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SCIENCE

17 November 1961

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AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

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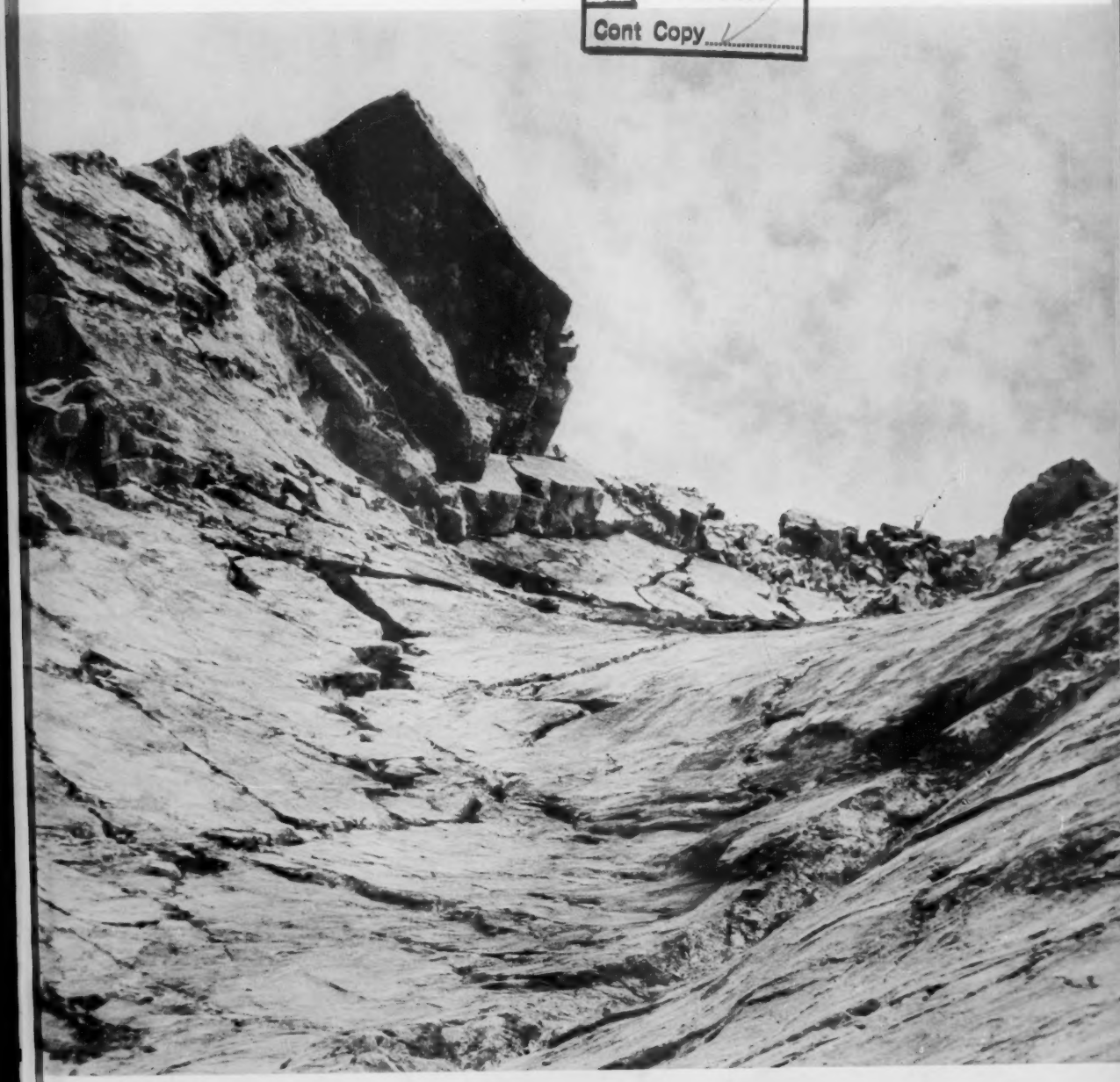

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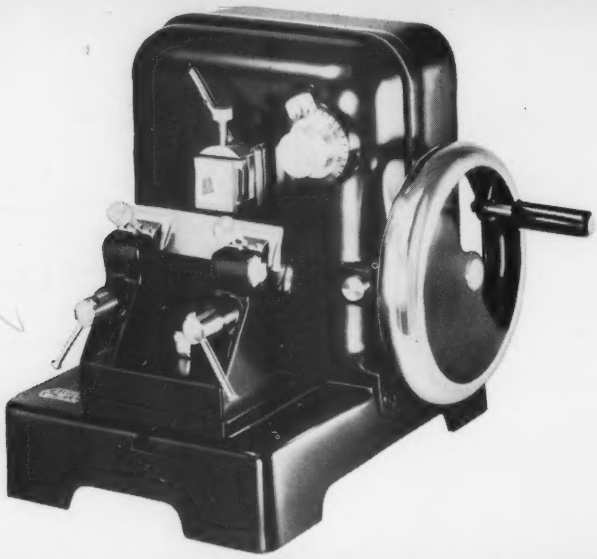

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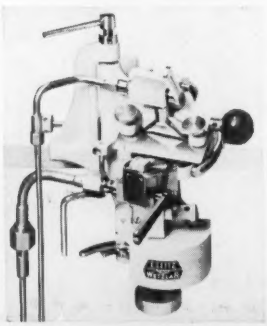

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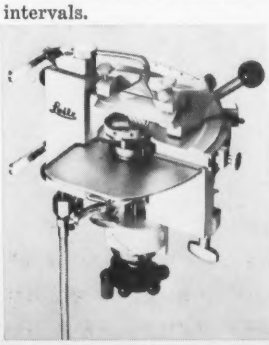

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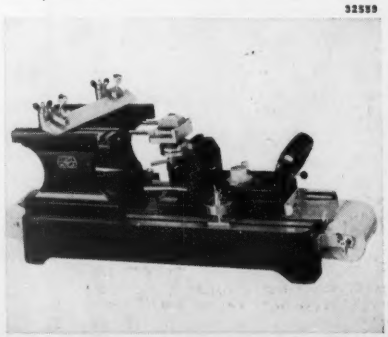

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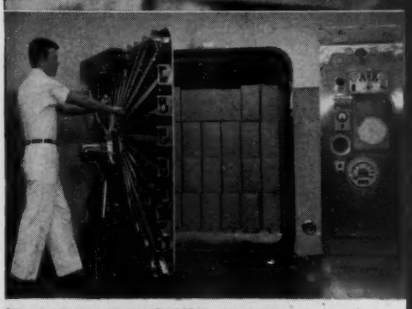

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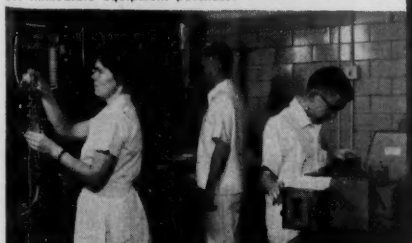

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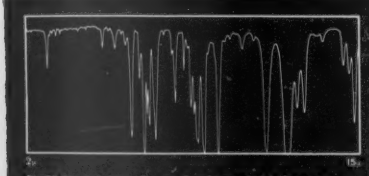

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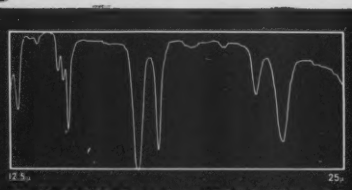
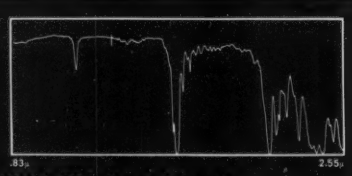


KBr Model 137. Scans from 12.5μ to 25μ in 6.5 minutes; provides data impossible or difficult to obtain at shorter wavelengths.



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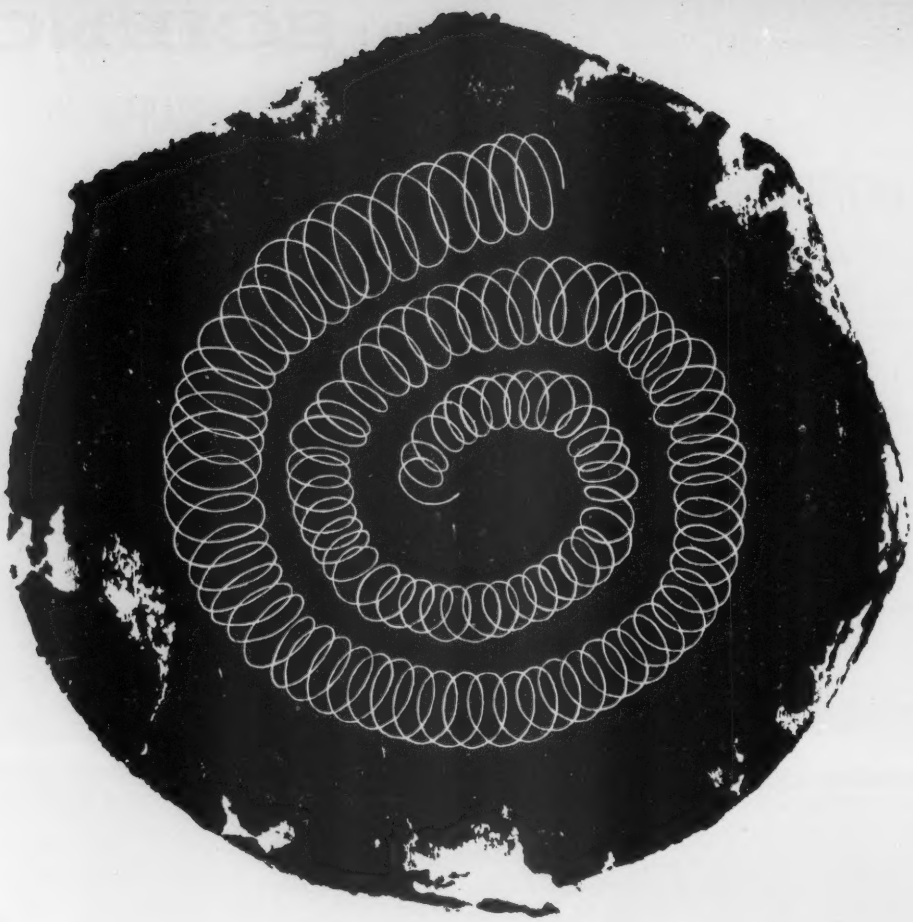
Cover

Mold after a megashatter cone on a southeast face of McCray quarry at Kentland, Indiana. The megashatter cone has been blasted away by quarrying operations. The mold impression is partially covered with a thin coating of injected breccia. The exposed dimensions of this cone structure are 28 feet at the base and 160 feet high. See page 1624.



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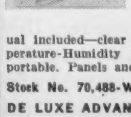

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The Search and the End Product

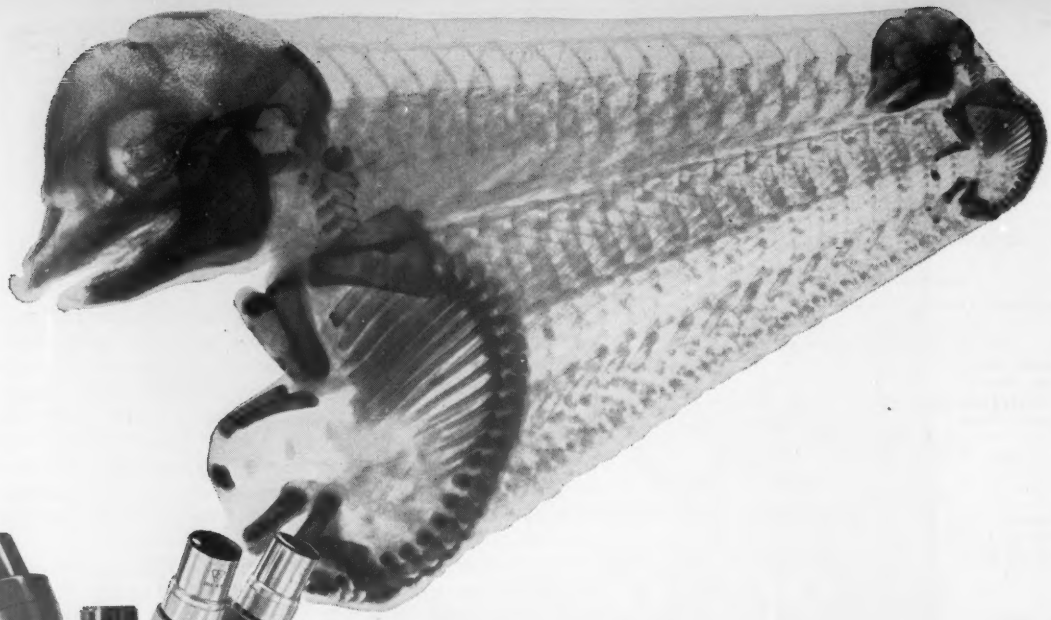
Human groups that admit of a multiplicity of values and purposes are inevitably confronted by two perplexing tasks: they must assign relative weights to individual goals and allocate priorities in the use of their group's resources. A democratic society assumes that ordinary citizens as well as policy makers are, at least on an intuitive level, capable of making such evaluations in a rational and commensurable fashion and that they do so not wholly on the basis of individual self-interest. What are the most suitable common measures on which a society can base its decisions? Specifically, what are appropriate indices for comparison when we deal with science and its possible applications?

Support for the broad spectrum of scientific research now greatly exceeds a just-noticeable fraction of our national budget. Thus it becomes necessary to decide each year what fraction of a finite amount of resources is to be allocated to the search itself, to research facilities, and to the communication and application of research results already available, and how much is to be set aside for the education of the young. One must also decide how much is to be allocated to the various component parts of the total scientific effort, and it is here that groups who are interested in different end products make themselves heard.

Most scientists are notably and justifiably reluctant to extrapolate from their laboratory experience to the benefits that society may eventually derive from their search. They would feel uneasy were they asked to prescribe an ideal "mix" of physical, life, and behavioral sciences. On the other hand, they are also aware that easily measurable quantities are not always the most useful ones. They are, therefore, not overly impressed by the fact that it is obviously easier to assess the cost of research, of an education—or for that matter of human well-being and freedom—than to estimate the value of these commodities; accurate ledger entries do not necessarily constitute correct bases for decision making.

This state of affairs threatens to leave us without a common language —we might almost say without a common currency other than the dollar. We can, of course, take the view that the values involved are intangible and imponderable and that only a nation adequately trained in science might get more than a vague impression in terms of attitudes, expectations, and hopes. Can we really do no better job of translating what science has wrought than to refer to megatons or appliances on a per capita basis? Here is a challenge to the ingenuity of our scientific advisory boards and science administrators. Here also is a challenge to social scientists and humanists. Let us look for new significant indicators of scientific and technological progress. Let us try to convey how the search for scientific knowledge constitutes, in modern societies, one of the most basic commitments to a better future for mankind. There is little chance that we shall find an all-encompassing index or formula, but we need to experiment with a variety of partially valid yet broadly comprehensible measures.

We can scarcely hope to achieve voluntary planning for the benefit of both a free science and a free society as long as we have so few tools for convincing our fellow citizens that without search today there may be no end products tomorrow.—WALTER A. ROSENBLITH, *Massachusetts Institute of Technology*.



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INSTRUMENTS AND TECHNIQUES

Stellar Scintillation

Stellar scintillation is shown to be a good indicator of the upper-air winds near the tropopause.

W. M. Protheroe

Except for dilution by the intervening space, the light from a star suffers little until it impinges upon the earth's atmosphere. In the short time required for the light to traverse the atmosphere, what was originally a plane-parallel wavefront becomes transformed into a corrugated wavefront by the refractive inhomogeneities which it encounters. When such a wavefront is sampled through the finite aperture of a telescope, several effects can be noted. The quality of the image formed by the telescope deteriorates from that predicted by physical optics; the image becomes enlarged and undergoes changes in size and position, since the direction of the normal of the wavefront is no longer constant, either in space or time. Furthermore, when the turbulence causing the refractive fluctuations is at a great distance from the telescope, of the order of kilometers, the intensity of the wavefront also becomes variable in both space and time.

This latter effect can be observed by viewing the illumination pattern from a bright star directly at the telescope aperture. The pattern appears to be crossed by a system of rapidly moving shadows and consequently is often called the shadow-band pattern. The total intensity of the telescopic image becomes variable, depending upon the sample of the shadow pattern selected by the telescope instant by instant. This variation in total intensity is called scintillation—or twinkling when the shadow pattern of a star is sampled directly with the eye. In the latter instance, the effective frequency of variation is cut off near 16 cycles per second, due to the time response of the eye. Scintillation may be studied either by measuring the fluctuations in image intensity for a given telescope aperture (*1*, *2*) or by measuring the shadow-band pattern directly (*3*–*5*). The results of both types of measurement are discussed here.

General Characteristics of Stellar Scintillation

While the observational characteristics of stellar scintillation have been discussed in detail elsewhere (*1*, *2*), it may be of interest to summarize some of these briefly. The more quantitative measurements have generally been made by means of photoelectric photometers. The fluctuating portion of the output current from the photocell, when corrected for shot noise, is directly proportional to the intensity variations of the shadow pattern integrated over the telescope aperture. This output signal is readily analyzed, with regard both to amplitude and to frequency distribution, by the techniques commonly applied to noise measurements.

The amplitude of the scintillation signal varies greatly from night to night and is strongly dependent upon both the size of the aperture and the altitude of the star above the horizon. For small apertures, say 1 to 3 inches, the peak-to-peak fluctuations of the signal as compared to the mean light level are of the order of 50 to 150 percent for stars near the zenith and can increase to several hundred percent for stars near the horizon. As larger apertures are used, the inherent fluctuations in the shadow pattern tend to average out; thus, the peak-to-peak amplitude for stars near the zenith may decrease to the order of 10 to 20 percent for apertures of 10 to 20 inches. The root mean square deviations of the signal are of the order of 30 percent for small apertures and fall off to the order of 5 to 10 percent for apertures measured in tens of inches. The strength of the scintillation also tends to increase whenever the wind field in the vicinity of the tropopause is strong, and hence, on the average, for mid-latitudes in the Northern Hemisphere, winter scintillation is stronger than summer scintillation.

The distribution of the scintillation signal with respect to frequency—that is, its Fourier spectrum—is another interesting parameter. This is likewise strongly influenced by size of aperture and by altitude and is even more strongly influenced by the wind field than is the total amplitude, or strength, of the scintillation signal. In general, for stars near the zenith, where small apertures are used the Fourier spectra tend to have a constant strength at frequencies from zero to around 100 cy/sec, with a decreasing strength from there to about 500 to 1000 cy/sec, where the amplitude becomes zero. On the other hand, when large apertures are used, the flat part of the spectrum extends to only 10 to 50 cy/sec, and the zero point is reached at anywhere from 100 to 500 cy/sec. The decrease in high-frequency components with increase in aperture size is readily explained as an aperture-smoothing effect.

As stars at lower altitudes are observed, the low-frequency components increase rapidly as the high-frequency components decline, and although the total bandwidth of the noise signal is quickly reduced, the low-frequency

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components increase at such a rate that the total noise signal over all frequencies still increases.

A seasonal variation in the frequency distribution of the scintillation signals was first noted by Mikesell, who observed that the cutoff point of the Fourier spectrum (that is, the point at which the amplitude goes to zero) occurs at higher frequencies during the winter. Since the upper-air wind speeds are known to be higher during the winter season, the seasonal variation of the crossover led to a search for a correlation of wind speeds with stellar scintillation. Another clue to such a correlation was suggested by the observations of Mikesell, Hoag, and Hall (*6*), who showed by placing a slit over the telescope aperture, that a directional effect was associated with scintillation. When the slit was in one position, the spectrum of the signal was characteristic of the signal from a large aperture; when the slit was at right angles to this position, the spectrum was more characteristic of a spectrum associated with a small aperture. Hosfeld (*7*) showed that this directivity was in fact related to the upper-air winds.

In searching for a suitable correlation parameter of the scintillation signal, other than the directivity effect, it was found that neither the amplitude of the signal (either total or at specified frequencies) nor the cutoff frequency gave reliable correlations of a quantitative nature with the upper-air winds, although definite trends in the data were readily noted (*2*). The amplitude of the high-frequency components and the cutout frequency in general increased when the upper-air wind speeds increased. Unfortunately these parameters are strongly influenced by the total strength of the scintillation, and since the scintillation signal can show rather large fluctuations in magnitude over short intervals of time, it becomes quite difficult to say whether the particular values measured reflect a change in strength of the signal or a change in the upper-air winds.

A quantitative description of the shape of the curve that was not strongly influenced by a variation of the signal amplitude was desired. In 1955 I proposed that the ratio of signal strength in a high-frequency band to signal strength in a low-frequency band be used as the correlate with wind speed, and I showed that this did indicate a relationship between scintillation and upper-air wind speeds in the vicinity of the tropopause that could be used as a measure of the wind speed (*2*). The wind speed was determined by taking geostrophic winds from the standard upper-air charts, the best correlation occurring for winds at the 200-millibar level. Since the geostrophic winds are, at best, only approximations to the true winds, it was decided to undertake a new program of observations which were to be made as nearly simultaneous with the upper-air wind soundings as possible, It was hoped that by such a procedure a definitive correlation might be made between the scintillation and the upper-air wind speeds.

Observational Program and Results

Preliminary tests, made at the Students' Observatory of the University of Pennsylvania, indicated that the directional effect was measurable with a slit as small as 1 by 4 inches. Consequently the scintillation measurements were made with a small-aperture telescope—one with a 4-inch aperture, as contrasted with the 12-inch aperture previously used.

The measuring equipment consisted of the 4-inch patrol camera of the Students' Observatory and a photoelectric photometer. A removable slit, 1 by 4 inches, which could be motor-driven through 190 degrees, was mounted over the objective. This mechanism was oriented in such a way that the zero fiducial of the slit was aligned with the direction of the true north when the telescope was in the meridian. The photocell output was amplified, and the noise-signal strength was measured in three pass bands, centered, respectively, at 10, 100, and 300 cy/sec. The ratio of the 100-cy/sec signal to the 10-cy/sec signal proved insensitive to the upper-air winds, especially at high wind speeds, and hence only the 300-cy/sec to 10-cy/sec ratios were used in the final correlations.

A normal observation consisted of two parts, a slit observation and a full-aperture observation. During the slit observation, the long axis of the 1- by 4-inch slit was rotated from the north to the south orientation and back. The output of the 300-cy/sec channel was observed, and the angular position

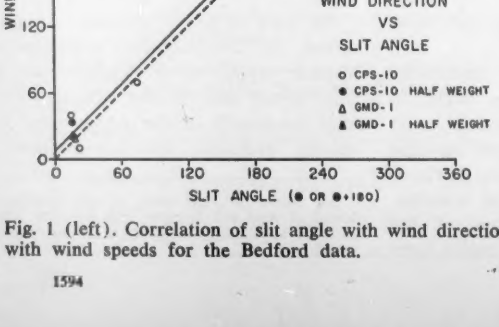

Fig. 1 (left). Correlation of slit angle with wind direction for the Bedford data.

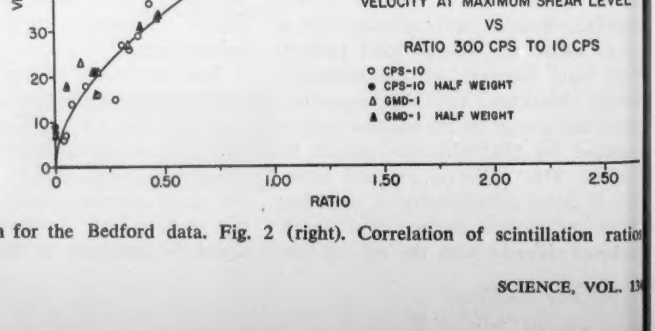

Fig. 2 (right). Correlation of scintillation ratios with wind speeds for the Bedford data.

of the slit corresponding to the minimum signal was noted when the slit was being driven in both the direct and the reverse modes. These two values were then averaged in order to remove the effect of a 10-second resistance-capacitance smoothing network at the channel output. This value was correlated with the upper-air wind directions.

The other part of the observational set consisted of a 5-minute reading with the full 4-inch aperture. The signals from both the 10 and the 300-cy/sec channels were corrected for instrumental noise by noting their values when the photocell was illuminated by a constant lamp adjusted to the mean illumination level of the star. The ratio of the high-frequency channel to the low-frequency channel was correlated with the magnitude of the wind velocities.

The scintillation observations were timed to occur as close as possible to 30 minutes after the normal release time of the balloons used for the 0300 Z upper-air soundings for the Philadelphia area. The balloons were released at a point approximately 10 miles due west of the observatory and were tracked by GMD-1 Rawinsonde equipment. The stars were always observed within 30 degrees of the zenith in order to insure that the layers causing the scintillation were being observed essentially normal to their stratification. This removed the necessity of making troublesome projection corrections.

Observations were made on 207 nights over 20 months, during which period radiosonde wind measurements were available for the Philadelphia area. Only 104 of the observations could be used, however, mostly because of inadequate meteorological data (the result, primarily, of failure of the balloon to reach sufficient altitude). Preliminary study of the data indicated that when the time differences between the balloon launchings and the scintillation observations were too great, discordant results were obtained. Consequently, only those observations in which the times of launching and of observation agreed to within 1 hour were used. This resulted in a final usable number of 67 observations.

In order to try to circumvent this problem of large attrition of the data and also to remove the objection of lack of control over the balloon soundings, it was decided to construct an instrument to be used at the Laurence G. Hanscom Field at Bedford, Massachusetts. Suitable meteorological equipment was in use at that field, and there was a further advantage in that a CPS-10 radar type wind-sounding instrument was available. This instrument gives reliable measures in high-velocity wind fields where the GMD-1 equipment becomes inaccurate. The scintillation equipment had the same aperture as that used at the University of Pennsylvania and was designed to be semi-automatic in its operation.

A total of 46 observations were made with this equipment on 36 nights. Of these observations, 22 were made in conjunction with the GMD-1 equipment, and 24 were made with the CPS-10 equipment. Observations for which the time of scintillation measurement differed by more than 1 hour from a time 30 minutes after the balloon release are not included in the above number. Observations made at times differing from the desired time by ½ to 1 hour were given half weight in the reductions. It was also decided to give half weight to observations made in conjunction with GMD-1 soundings when the wind speeds were in excess of 60 meters per second. There were nine such half-weight observations in the 46 observations available for analysis.

Table 1. Comparison of the results of the scintillation and wind correlations obtained with the GMD-1 equipment at the University of Pennsylvania and with the GMD-1 and CPS-10 equipment at Bedford.

Observations (No.)	Windspeed (m/sec)			Probable error (m/sec)	Wind direction (deg)			Probable error (deg)
	a	b	ρ		α	β	r	
	University of Pennsylvania (GMD-1 equipment)							
67	32.6 ± 0.7	0.49 ± 0.04	0.795	5.3	5.6	0.990	0.988	5.6
	Bedford (CPS-10 or GMD-1 equipment)							
46	59.6 ± 0.8	0.50 ± 0.02	0.957	4.1	5.3	0.998	0.994	6.4

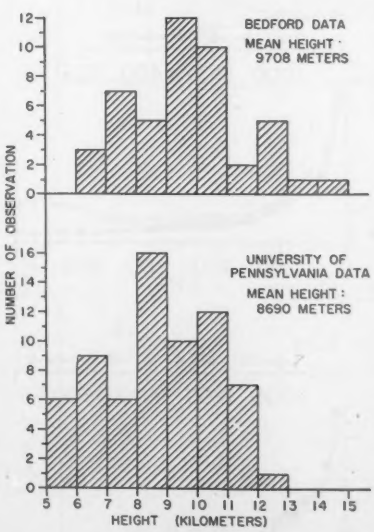

Fig. 3. Distribution of shear layer heights used in the wind correlations. The layers were chosen for each observation by selecting the layer at which the maximum vector gradient occurred in the vertical wind profile.

The two sets of data—University of Pennsylvania and Bedford—were reduced separately. While only the Bedford results are shown in Figs. 1 and 2, the final results for both locations will be discussed. Both sets of data gave the best correlation when values for winds at the maximum vector gradient were used.

The wind direction versus the slit angle (or the slit angle increased by 180 degrees since the sense of the motion of the pattern is indeterminable by this technique) was fitted by a linear relation

$$A = \alpha + \beta\theta$$

where A is the wind direction, α and β are constants, and θ is the slit angle.

The scatter diagram of the wind direction plotted against the slit angle for the Bedford data is presented in Fig. 1. The dashed line is the line of perfect correlation, while the solid line is the line fitted to the data by least squares. As given in Table 1, the resulting correlation coefficients r, for both the University of Pennsylvania and the Bedford data, are quite high. These values are beyond those expected from chance occurrence, as may be seen by noting that the odds are 100 to 1 that the correlation coefficient for the University of Pennsylvania data will not exceed 0.312 if the wind direction and slit angle are not related and, similarly that the correlation coefficient will not exceed 0.393 for the Bedford data. The probable errors of 5.6 and 6.4 degrees, respectively, are well within the limits

of errors usually associated with the meteorological data.

The plot of wind speed against the scintillation ratio was fitted by a relation of the form

$$V = aR^b$$

where V is the wind speed in meters per second, a and b are constants, and R is the ratio of the 300-cy/sec component to the 10-cy/sec component.

The plot for the Bedford data is shown in Fig. 2, where the solid curve, of the form given above, was fitted by least squares. The indices of correlation ρ for the University of Pennsylvania and Bedford data, given in Table 1, are 0.795 and 0.957, respectively. The statistical significance of these results can be demonstrated by the fact that the odds are 1000 to 3 that the value for the University of Pennsylvania data will lie between 0.611 and 0.898 and that the value for the Bedford data will lie between 0.941 and 0.968. The probable errors of estimate for the two sets, 5.3 and 4.1 meters per second, respectively, are again well within the usual limits of uncertainty in the meteorological data. The difference in the a coefficients for the two locations arises from a difference in calibration of the two systems, which were somewhat different in design.

The distribution of the heights of the shear layers used in the correlation is presented in Fig. 3. The mean height for both observing sites is around 9000 meters, which is near the tropopause. That the turbulence causing stellar scintillation is expected to be at a considerable distance from the telescope has already been predicted by Keller (*8*) and Tatarsky (*9*). Image distortion is, however, caused by refractive inhomogeneities at all layers, even within the telescope itself.

While the correlations between the scintillation parameters and the wind speeds are quite good, it is not yet possible to state that there is a 1-to-1 relationship between the wind speed and the scintillation ratios. This is obvious from Fig. 2, where individual points may have relatively large deviations from the predicted values. That relatively large deviations may be found is, however, to be expected. In the first place, while an attempt was made to insure that the balloon soundings and the scintillation measurements would be as nearly simultaneous as possible, deviations as large as 1 hour had to be tolerated in order to have a statistically significant sample. It is well known that the upper-air wind fields can undergo large fluctuations in short periods of time. For example, on one night when multiple balloon soundings were made at Bedford, the wind underwent a vector change of 25 meters per second in the tropospheric region in 52 minutes. This is undoubtedly an extreme illustration, but it does indicate the relatively large effects encountered. Possibly more important than the time fluctuations of the wind field are its spatial fluctuations. These are particularly troublesome when high winds exist, since the sounding balloon may be transported tens of miles away from the observing site by the general wind movement while the telescope is looking through the wind field directly over the site. Another factor is the possibility of changes in the structure of the shadow-band pattern from night to night. The fact that the correlation is as good as it is indicates that the pattern structures on different nights can be expected to be quite similar. This relative constancy of structure was verified by the Optical Fourier Analyzer measurements described in the next section. Even though it is still not possible to state that the relationships given above are definitive and could be used for actual measurement of the upper winds, it does appear safe to conclude that stellar scintillation is an excellent indicator of the winds at the maximum-vector shear layer.

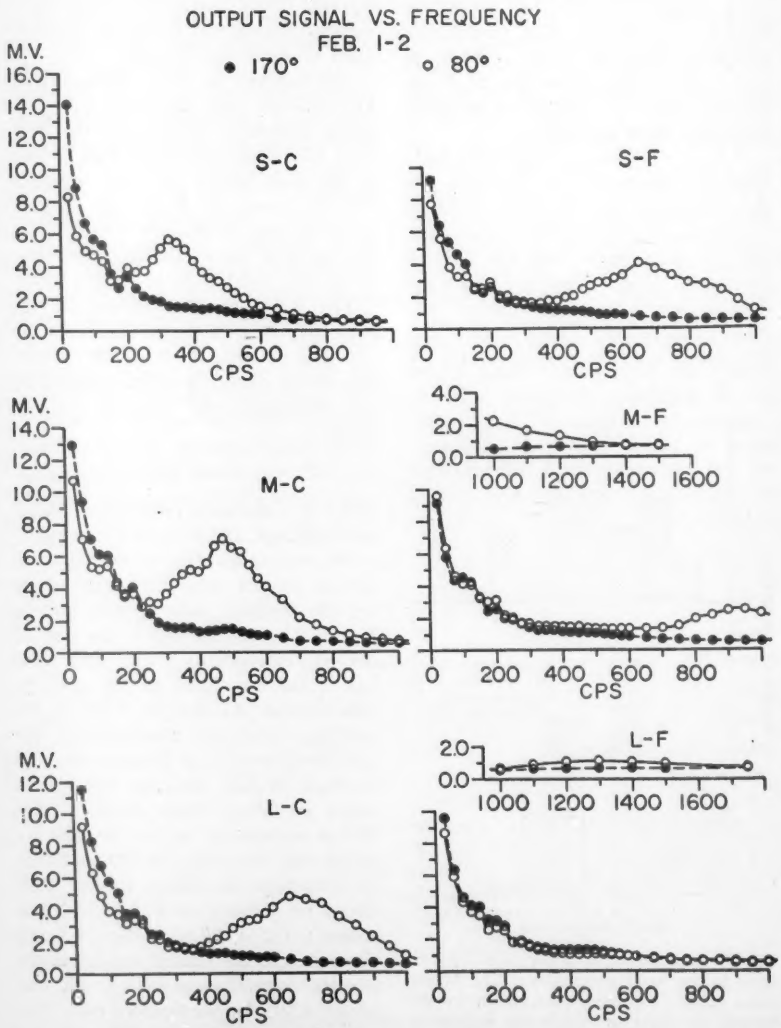

Fig. 4. Harmonic spectra of the photocell signal for the six lens-grating combinations on 1 and 2 February 1959.

Optical Fourier Analyzer

The observations just described do not give any direct information about the shadow-band pattern structure and hence about the atmospheric turbulence causing it. In order to make studies of the pattern structure, the Optical Fourier Analyzer was designed.

This is an instrument which permits measurement of the spatial power spectrum of the shadow-band pattern (*5*). It is essentially the optical analog of an electrical filter. Briefly, it functions by imaging the shadow-band pattern from a given star upon a transmission grating. Ideally, the grating should have a sinusoidal transmission function in one direction and a constant transmission function perpendicular to that direction. The grating actually used, however, was a Ronchi grating—that is, one that has a square-wave transmission function rather than a sinusoidal one. The total light transmitted by the grating is the product of the grating transmission function and the spatial intensity function of the shadow pattern. If this light is measured by a photocell, an electrical signal is generated which is proportional to the instantaneous product of the two functions. It is obvious that for a sinusoidal transmission function this signal is nothing more than the intergrand of the Fourier integral for that portion of the shadow pattern which is imaged on the grating, and that it corresponds to the wavelength associated with the grating spacing. When a square-wave transmission function is used, the odd harmonics of the principal spatial frequency of the grating are also introduced, but fortunately for the observations under discussion, it can be shown that the higher harmonics are of no measurable importance. Since the shadow pattern is time-dependent, the output of the photocell will also fluctuate with time. The time average of the fluctuating signal will be related to the strength of the spatial component of the shadow-band pattern, having a wave number corresponding to that of the transmission filter (*5*). The effective band pass of the spatial filter will be a function of the shape and size of the shadow pattern analyzed: the larger the sample, the narrower the effective band pass of the filter.

If the pattern is now imagined to be fixed—that is, to be without formation or decay of pattern elements—in translation along the direction of density variation of the grating, the output of the photocell will contain a constant frequency signal. The strength of the signal will be related to the strength of the shadow-band element size corresponding to the wave number of the grating. The frequency of the signal will be related to the element size and the velocity of translation according to the relation

$$V = lf$$

where V is the translational velocity of the pattern, l is the linear size of the pattern corresponding to the wave number of the grating, and f is the frequency of the photocell output signal in cycles per second.

In practice, the pattern undergoes a change with time as well as with translation, and hence the contributions to the fluctuating portion of the photocell output will be made over a wide frequency range. The strength of the pattern element will thus be related to the total strength of the fluctuating signal taken over all frequencies, while the predominating frequency will permit determination of the pattern velocity according to the expression just given. The half-width of the signal about this enhanced peak will depend upon the band pass of the optical filter and the rate of the growth and decay of the pattern.

In order to determine the complete spatial power spectrum of the shadow-band pattern it is necessary to have gratings corresponding to as many different wave numbers as are required to give the desired coverage. Those of small wave number—that is, of large element size—are limited by the pattern sample available. The practical limit is reached when the sample size is about three times the element size. The lowest possible spatial frequency in

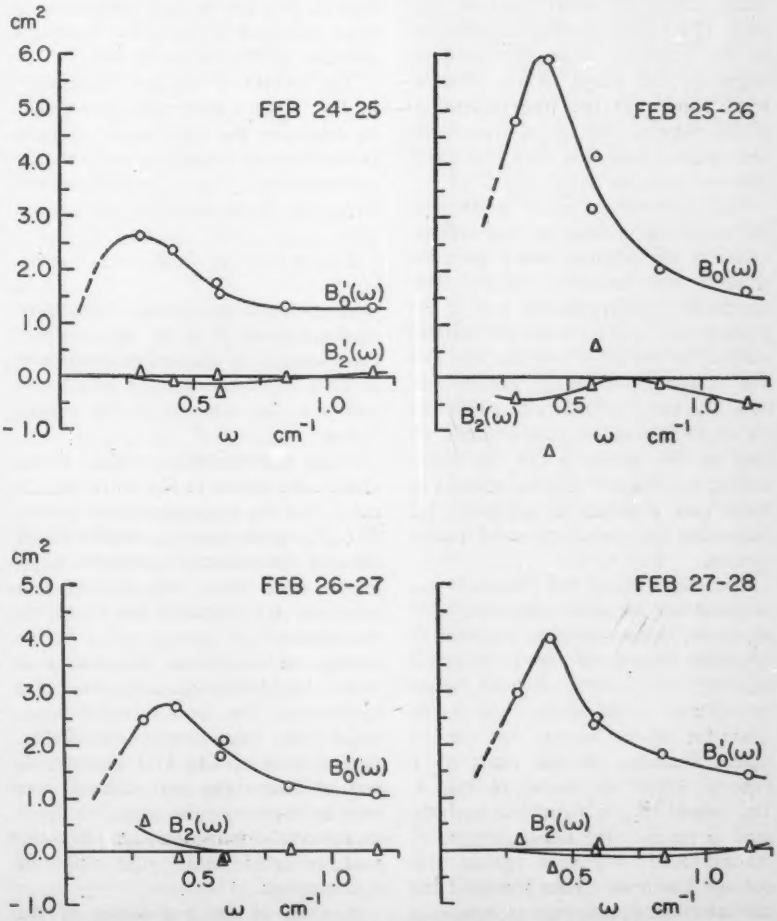

Fig. 5. Representative spatial power spectra of the shadow-band pattern on four nights in February 1959.

Table 2. Characteristic wavelengths and spatial frequencies of the available lens-grating combinations.

Lens*	Wavelength (cm)	Spatial frequency (cm^{-1})
Coarse grating (25 lines/inch)		
Short	21.08	0.298
Medium	14.94	0.420
Long	10.77	0.583
Fine grating (50 lines/inch)		
Short	10.54	0.596
Medium	7.47	0.840
Long	5.38	1.165

* Focal lengths (in inches) as follows: short, 2; medium, 3; long, 4.

the work described here was thus 0.298 cm^{-1} (or a wavelength of 21.08 cm), since the telescope used for the measurements was the 28-inch reflector of the Flower and Cook Observatory.

Six spatial frequencies were used by combining two gratings, designated fine and coarse, and three projection lenses, designated short, medium, and long. The known optical magnification of the projection lenses permitted relation of the image of the shadow-band pattern to the true dimensions of the pattern. The spatial frequencies and element sizes that were thus available are given in Table 2.

The observations were made with the analyzing gratings in two orientations: in one position, which gave the smallest high-frequency output from the photocell, the constant axis of the grating was aligned with the pattern motion; in the other position the axis was perpendicular to the pattern motion. The same procedure was followed for all six grating-lens combinations. As long as the pattern is not too asymmetric, the analysis with the gratings in these two positions is sufficient for measuring the two-dimensional power spectra.

The output from the photocell was recorded on magnetic tape and, subsequently, upon repetitive playback, a harmonic analysis of the 12 recorded signals, two signals for each of the six grating-lens combinations, was made. Examples of the spectra for the 12 signals recorded on the night of 1 February 1960 are shown in Fig. 4. The output of the harmonic analyzer used to measure the signal strength of the photocell is plotted against frequency. The open circles represent the case when the square-wave transmission function of the grating is aligned with the pattern motion; the solid circles, the case when the grating is at right angles to this orientation. The frequency of the signal peaks is directly proportional to the wave number, as would be predicted by the relation between pattern velocity and grating spacing. The calculated pattern velocity averaged over the combinations was 70.5 ± 1.07 meters per second at a direction of 80 (or 260) degrees measured clockwise from the north. Measurements of this type were made on 18 nights and gave values for the pattern speed and direction consistent with upper-air wind speeds. A direct comparison with the winds was not possible since radiosonde measurements were no longer being made in the Philadelphia area. On only one night was the pattern speed found to be indeterminable by this method. On eight nights, however, multiple peaks were found, indicating the possibility that several patterns were being superimposed. Multiple patterns of this sort tend to give rise to bad measurements when observed by the other technique described in the preceding section.

The spectra of the type represented in Fig. 4 were integrated numerically to determine the total signal strength. If the shadow pattern is not radically asymmetrical, the two-dimensional power spectrum may be written

$$B(\omega, \phi) = B_0(\omega) + B_2(\omega) \cos 2(\phi - \theta)$$

where B_0 is the symmetrical component of the pattern, B_2 is the asymmetrical component, ω is the spatial frequency, ϕ is the azimuthal angle of the pattern, and θ is the azimuth of the pattern motion.

Four representative spatial power spectra are shown in Fig. 5. It may be noted that the asymmetrical component $B_2(\omega)$ is quite small in amplitude and that the symmetrical component peaks near $\omega = 0.5$ cm^{-1}. This peaking was noted on all but four of the 18 nights; the element size corresponding to the average of the spatial frequencies at which the peaks occurred was 15.6 centimeters. The peak element sizes, when the peaks were measurable, ranged from 12.8 to 17.7 centimeters, and of course the peak element size must have been greater than 21.1 centimeters on the four nights on which the peak occurred outside the range of measurement.

Analysis of the half-widths of the frequency peaks, on the assumption that the pattern growth and decay is exponential in character, leads to the conclusion that the pattern elements have lifetimes measurable in milliseconds to tens of milliseconds. The shadow patterns are therefore quite transitory in nature, not only because of their rapid motion but also because of their rapid structural change. This introduces difficulties when other methods, such as that of determining the autocorrelation function of the pattern by means of two telescopes of variable separation, are attempted in order to extend the power spectrum into the long-wavelength region (*4*). If the longer-wavelength measurements are desired, it appears that the best way to obtain them is to use the Optical Fourier Analyzer with a large telescope aperture.

Summary and Conclusions

The ratio of the stellar scintillation signal in a frequency band centered at 300 cy/sec to the signal in a band centered at 10 cy/sec generated when a star near the zenith is observed with a 4-inch circular aperture has been shown to be dependent upon the upper-air winds. These ratios are capable of indicating the wind speeds at the level of maximum vector gradient with an accuracy comparable to that normally attained by conventional radiosonde measurements. Furthermore, when a 1- by 4-inch slit is placed over the telescope aperture, the wind direction, but not its sense, may be determined by noting the alignment of the long axis of the slit which gives the minimum 300-cy/sec signal.

The Optical Fourier Analyzer, a device which permits measurements of the two-dimensional spatial power spectrum of the shadow-band pattern, has given data upon the spatial and temporal structure of shadow-band patterns. The shadow-band pattern elements are characterized by a size of 15 to 16 centimeters and have a lifetime of the order of several to 10 milliseconds. A direct determination of the velocity of the pattern motion across the telescope is also possible and indicates that the pattern velocities are comparable to the upper-air wind velocities. The observational results on some nights can best be interpreted on the basis of two or more simultaneous patterns moving with different velocities (*10*).

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Competitive Exclusion

The exclusion principle is recast in the context of a generalized scheme for interspecific interactions.

Bernard C. Patten

The colloquy in these pages (*1*) concerning the newly denominated but ancient theory of "competitive exclusion" has generated a controversy which appears to have resulted in a standoff. One wonders if the reason may not be implicit in A. N. Whitehead's remarks when he admonished his contemporaries for living off the intellectual capital accumulated in the 17th century, warning that any culture was doomed which could not throw off the inertia of habitual thinking and burst through the facade of its own concepts. Exclusion theory is controversial, it would seem, not so much because it isn't intuitionally reasonable or, for the most part, empirically expressed, but rather because it is couched in an archaic context of 19th-century dogma within which circular reasoning is the only alternative to progress (in terms acceptable to modern apprehension of scientific episteme). This circularity is reflected in the earliest and latest formulations of the exclusion principle:

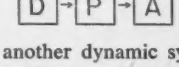
> . . . it is the most closely-allied forms—varieties of the same species, and species of the same genus or related genera—which, from having nearly the same structure, constitution and habits, generally come into severest competition with each other; consequently, each new variety or species, during the progress of its formation, will generally press hardest on its nearest kindred, and tend to exterminate them. [Darwin, 1859]
>
> [Since] complete competitors cannot coexist . . . ecological differentiation is the necessary condition for coexistence. [Hardin, 1960]

Thus the total achievement of a century of thought amounts to providing the contrapositive of the original proposition.

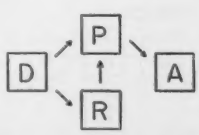
The exclusion principle is regarded in this article as a legacy from the past, whose continued recognition at "law" status can only interfere with a healthy development of concepts whose further disquisition it tends to block. Therefore it should be relegated as prudently and expeditiously as possible to a de-emphasized position in a broader, more modern framework. A tentative step in this direction is provided, which casts exclusion in a context which includes also the cooperative aspects of interspecific phenomena. Strong reliance on cybernetic models as formulated by Ashby (*2*) is acknowledged.

Consider a universe Υ of entropy states, some at higher and others at lower levels of potential. Discrete enclaves of high potential (the sun for example) represent sources of unconstrained variety (information, negentropy) which transmit to low-potential sinks comprising states of maximally constrained variety (entropy). Let the subset v represent the biological states in Υ at intermediate potentials. This collectivity, consisting of states of partially constrained variety, possesses the capacity to impose constraint upon information and so to generate entropy—an accomplishment, as will be shown, which requires an information store which v seeks to maintain (and extend) contrary to the gradient of potential. The situation is analogous to a two-person von Neumann game of the non-zero-sum type (*3*) in which v simultaneously seeks to gain information from Υ for use in blocking its gain of information from Υ. Solution of this paradox constitutes the fundamental problem of regulation. Two basic principles are involved: the law of entropy and the law of requisite variety. These laws are best discussed against a background of the nature of v's organization.

Consider, as a functional element of v, "species" A, which regulates a set of essential variables within a favorable range α beyond which A fails to survive. The subset α corresponds to a Hutchinsonian niche (*4*). Disturbances D, in the form of information from the environment Υ, threaten to drive the states of A outside of α. If D may be visualized as acting through some dynamic system P, a protocol characteristic of Υ, then the initial diagram of immediate effects takes the form



A forms another dynamic system R, a regulator which can be coupled to P to produce a machine capable of blocking the flow of variety to the essential variables:



The "game" takes the following sequence: (i) the environment Υ makes an arbitrary move D; (ii) R assumes a value determined by D's value; and

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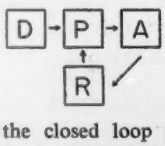
(iii) P determines the outcome which is or is not in α. The process is incessant, and the sequence of events constituting the "life" of any discrete informational unit a of A may be represented as

$$D_1\ a_1\ D_2\ a_2\ D_3\ \ldots$$

—a sequence which continues until a falls outside of α. It is noteworthy that A's regulation need not be perfect; it only has to be "good enough" (and, disturbingly, the a's are freely expendable).

"Good enough" regulation may be of two kinds: a priori and a posteriori. In the former, D and R act simultaneously on P to produce a state change in A. The strategy of this defense against variety is that of a gambler—playing the odds. A regulator of limited capacity is employed to handle variety within a certain fixed range (say, for example, three standard deviations). This is cheap regulation, and when D exceeds the range of R's effectiveness, the essential variables fall beyond α and many or all of the a's fail to survive. This kind of regulation is commonplace in biology, and disturbances of uncommon magnitude lead to "cycles" of rarity and abundance, and to such catastrophic phenomena as mass mortalities. Essential to a program of a priori regulation is a residuum of variety stored in very effective (n standard deviations) regulators, such as resistant seeds and spores, to function as information sources for repopulation when the D's return again to normal levels.

Regulation a posteriori is much more sophisticated, and the entity regulated has far more integrity and is far less expendable. This is error-controlled regulation in which D produces, through P, a perturbation in A, which then transmits information concerning its displacement to R, which then acts on P to correct the error in A's trajectory. Like a priori regulation, this control by negative feedback is not perfect; in fact, the method relies on error. Perfect control in this case corresponds to no control! A diagram of immediate effects



illustrates the closed loop *ARPA*.

Regulation by error is most keenly developed in the higher behavioral phenomena of higher organisms, but it is also important, although more subtle, at the ecological level. An excellent example is provided by Cruikshank's data on the abundance of three species of warbler in successive years in Maine, cited by MacArthur (*5*). The trajectories (where i represents increased abundance over the preceding year, and d, decrease) were

Myrtle	*didiiiddidid*
Black-throated green	*iididdidi*
Blackburnian	*idiididid*

for which the corresponding matrices of transition probabilities are

Myrtle

▼ |	d	i
d	.17	.67
i	.83	.33

Black-throated green

▼ |	d	i
d	.20	.80
i	.80	.20

Blackburnian

▼ |	d	i
d	.20	.83
i	.80	.17

These matrices show clearly that each species of warbler tends to increase when it is rare and to decrease when it is common, a neat illustration of feedback control at the population level.

Laws Basic to Regulation

Let us return now to the two laws basic to regulation—the entropy law and the law of requisite variety. As discussed earlier, external variety can only be blocked by internal variety supplied to a regulator. The law of requisite variety (*2*) fixes exactly the amount of regulation achievable by establishing the lower limit to which A's variety can be depressed; it is

$$\frac{D\text{'s variety}}{R\text{'s variety}}$$

This principle is isomorphic with Shannon's (*6*) theorem 10 concerning the data-handling capacity of correction channels. For a given D, therefore, R's variety must be commensurately high in order for A's states to be constrained within α. Should A falter in providing the necessary information when it is needed, it fails to survive—that is, it ceases to continue as a functional entity of v. The entropy law, a general principle of which the second law of thermodynamics is but a particular expression, works against A's regulatory efficacy by passively providing the gradient against which required variety must be accumulated. That this law operates automatically as soon as convergence occurs in a transformation is shown by the following transformation:

$$T: \downarrow \begin{matrix} M\ N\ O \\ N\ O\ O \end{matrix}$$

in which the operand has a variety of 1.6 bits per element ($-3/3 \log_3 1/3$) and the transform a variety of 0.9 bits per element ($-1/3 \log_3 1/3 - 2/3 \log_3 2/3$). A second application of operator T produces a variety of zero, the maximum entropy condition.

A more concrete example may be obtained from biochemistry. When, in the tricarboxylic acid cycle, succinate is transformed to fumarate, some 36 kilocalories per mole are liberated, representing an entropy gain which cannot be reversed *within* the limited framework of the Krebs system. For the cycle to continue, new variety in the form of pyruvate from the glycolytic chain must be provided. This comes, ultimately, from Υ.

The foregoing conditions under which A must preserve its integrity are basic to the following proposition, upon which an approach to the competitive exclusion concept may be based. The proposition, a suggested working hypothesis, is that selective advantage accrues to those elements of v which regulate best, in the sense of achieving unit stability at the lowest cost in information. We shall examine interspecific phenomena in relation to this hypothesis.

Let us consider another species, B, having niche β. Several relationships are possible between A and B. If the phase spaces α and β have no points in common in space and time, A and B are completely independent. But when the niches overlap to some degree spatially and temporally, the species interact, which is to say that their components become coupled to form a new machine AB of epispecific proportions. A biocenose—that is, an ecological community Γ—may be regarded as a large functional element of v made up of the combined coupling of numerous species with intersecting niches ($\Gamma = AB\ \ldots\ Z$). Hence Γ, like each of its components, is itself a self-regulating device which strives to maintain at lowest possible cost *its* essential variables within a favorable range $\gamma\ (\alpha\ \beta\ \ldots\ \zeta)$. Competition, and the antithesis cooperation, may be defined in terms of the total success of

Γ in meeting that goal. If efficacy in regulation of any coupling AB is greater than the combined efficacy of its elements before interaction (that is, $A + B$), then the interaction is favorable—cooperative—and will tend to be perpetuated. Cooperative interactions generally occur when A and B are only remotely related—that is, when α and β do not overlap appreciably. When niches are similar, however, a couplet may prove to have reduced regulatory capacity, and Γ tends to revert to a more favorable state by eliminating one of the competitors—the one which, functioning separately, is the least effective regulator. This is the exclusion principle—a modern expression of the "struggle for existence."

Experimental Evidence

The best experimental evidence for the validity of the theory has been provided by the work of Thomas Park and his colleagues (*7*) with flour beetles. In every experiment in which two closely allied species of beetle were forced to cohabit a limited environment, one of the species survived while the other was eliminated. In a given experimental situation, however, it was not always the same species which survived. But (and this is of the utmost significance) the species surviving most often was the one which sustained higher densities when grown alone under conditions of temperature and humidity identical to those for the other species. An exception to this rule was observed in treatment 5 (*7*), in which the species which survived most often in competition was the one which, grown alone, maintained the lower density. A possible explanation for this, and also for the seemingly stochastic nature of the general result (only at the environmental extremes did the same species win every contest) may be that a "head count" is probably a pretty crude measure of variety.

Cole, in his rebuttal to Hardin's exposition of competitive exclusion (*1*), stated, "No two species can remain sympatric indefinitely whether or not they compete." Park and his coworkers did not rule out this consideration in the case of the *Tribolium* model. When the model is viewed as a Markovian machine, the prediction is that over an infinitely long time either the beetles must succumb or their population must grow to infinity. Comparing this with the experimental results (maximum duration 1860 days), Park and his associates conclude that either (i) the probabilities of growth, death, and passage from state A_i to A_{i+1} do not depend solely upon the state of the operand but depend also on the history of the population prior to A_i, or (ii) the period of observation was much less than infinite. The authors "guess" in favor of the second alternative; their position is strengthened by the fact that the first is cybernetically unsound: any transition depends only on the state of the operand at the time the operator acts. The fact that exclusion always occurred in a short time relative to the total potential life of each culture indicates that the *ultimate* disappearance of an element A from the community Γ as the normal consequence of the latter's evolution toward a more favorable position with respect to the working hypothesis is inadmissible as an argument against competitive exclusion.

Let it be noted in conclusion that nothing in the cybernetic model presented precludes the possibility of passive coexistence between A and B. As a matter of fact, if competitive interaction lies at one coupling extreme and cooperation at the other, then what is more natural than that at some point intermediate in the continuum there be a coupling in which AB is neither less nor more effective in total regulatory capacity than $A + B$? Hence, such models as Skellam's describing coexistence (*8*) are not necessarily incompatible with the exclusion principle.

Summary

Two species, A and B, interact when their niches α and β intersect in space and time. The composite element AB may be either more, less, or equally effective in regulation. It is suggested that the first condition exists when the overlap between α and β is small; this leads, on a large scale, to complex biocenotic phenomena in which components of a tremendously diversified biota may coexist. The coupling AB is likely, on the other hand, to be antagonistic to optimization of regulation by the whole community; in this case, it is postulated, one of the components (the less effective regulator acting alone) is purged. This is competitive exclusion, and it develops when α and β intersect greatly. Between these extremes of cooperation and competition lies an area of niche intersection in which AB is not much better or worse than A or B alone. This case gives rise to passive coexistence of A and B. These are the extremes; even a cursory consideration of the permutational possibilities for niche intersection gives an immediate concept of the overwhelming variety of possible interspecific interactions and a glimpse of the dangers inherent in overemphasizing a single aspect. It is therefore advocated that the principle of competitive exclusion be regarded as only a small segment of a broad class of interspecific phenomena (*9*).

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Science and the News

Money for Space: The Program's Managers Fear the Public Does Not Understand the Issue

The space budget next year will be about double what it is this year: about $3 to $3.5 billion compared to $1.7 billion during the current year. The figures are a bit higher than those talked about when the President proposed the accelerated program last spring, but they are not surprising, and Congress will almost certainly accept them without too much fuss. The Administration put a great deal of emphasis last year on the point that it would make no sense for Congress to provide the money for the first year of the accelerated program unless it were prepared to follow through with the even larger appropriations that would become necessary in succeeding years to keep to the accelerated time schedule. This did not put Congress under a legally binding commitment to continue support for the program, but as a practical matter the commitment was implied when Congress put up the first year's appropriation, and the Administration is likely to get the money it asks for. Nevertheless, there is a good deal of anxiety within the space agency and General Shriever's Air Force Research and Development Command, which has charge of most Defense Department space programs, that the public does not really understand where the money for space is going, and why it is, in the Administration's view at least, well worth spending.

At the American Rocket Society meeting in New York last month, Shriever, Wernher Von Braun, and Hugh Dryden, chief scientist at the Space Agency, all gave pretty much the same reply when they were asked to wind up a panel discussion of the space program by suggesting what they would wish for the space program above all in the coming year: all three men spoke of a hope that the public would come to understand what is involved in the space program, for without this, they suggested, continued support for the program would be threatened. What bothered them was that a great many people seemed to think of the entire space program as an elaborate stunt in which $20 billion would be spent to put one man on the moon. All the panelists were plainly concerned that the public does not understand the difference between what would be the overt sign of the project's success—that is, sending a man to the moon and bringing him back—and the thing that is really being bought for the $20 billion: the major advances in science and technology that will make the first trip possible. The interesting thing about this problem is that although the public misunderstanding seems to be widespread, it does not present any serious obstacle as yet to the Administration's getting the money it wants for the program.

Congressmen concerned with the space program regularly warn the Administration that they are getting a good deal of mail from voters who think the project is a stunt and not worth the money, but the lack of understanding has an almost secret status: there is no real public debate on the wisdom of the accelerated program, and no sign that any is developing. Last year the program swept through Congress with no difficulty at all, despite the concern expressed by a number of important Congressmen, who said they were having trouble explaining the program to their constituents.

What has happened is that there is an overwhelming coalition of political forces behind the space program, so overwhelming that the doubts that exist among the public are almost never articulated by a source commanding the attention of a large share of the public. The space program has come to be accepted by all the major political factions as an aspect of the Cold War. The Kennedy Administration is under attack for not pursuing the Cold War with sufficient vigor. The result is that even its strongest opponents, since they accept the assurances of the Defense Department that developments in space will have major military implications, have no desire to exploit the public's misunderstanding of what is being bought for the $20 billion that will eventually be spent on the moon program. The space officials are anxious to clear up the public's misunderstanding, and so to remove even the possibility of its being exploited, but although their anxiety is understandable, they really do not seem to have much to worry about.

In all this former President Eisenhower occupies a peculiar position. He is the one major political figure in the country who *is* outspokenly against the space program. Last week he told an audience at Case Institute of Technology that he could not understand why the Administration, at a time when the federal budget seemed to be getting out of hand, should choose to challenge the Russians to a race to the moon. The remark struck a sympathetic note for the audience, or at least part of the audience. It brought the only outburst of applause that came during his 30-minute talk.

A couple of weeks earlier, while campaigning for the Republican candidate for mayor of New York, Eisenhower had sought to ridicule both the space program and the Peace Corps by suggesting that as long as the Administration was so interested in experiments in space, it might try sending the Peace Corps to the moon. About the same time, the New York *Times* printed a long story summarizing the results of a series of interviews with the general and members of his staff. The *Times* reported that Eisenhower felt the sole reason for the moon program was that the Administration was looking for any excuse to spend more money.

But there has been no sign at all that Eisenhower, despite his prominence, has succeeded in arousing any significant popular opposition to the space program, despite fears of the space officials that there is a good deal of latent opposition around just waiting for a leader to bring it to life. This is

not really surprising, for at the moment Eisenhower is a captain with no lieutenants. Like an advertising man who wants to sell some toothpaste, a politician who wants to sell an idea has to keep repeating it over and over again, and see to it that the same idea is echoed over and over again by his followers. But there is no one to pick up Eisenhower's lead, either among other major political figures or in the mass-circulation press, for there is no significant faction in American politics that shares his view that the Administration has no better reason for supporting the space program than as an excuse to spend money.

What public discussion there has been on the space program has not been on the overall question of whether too much emphasis is being put on the whole business, but on matters of detail, such as the technical question of how to get to the moon most efficiently and the administrative question of how to deal with the sometimes conflicting jurisdictional claims of the civilian Space Agency and the Air Force.

On getting to the moon, Von Braun's longstanding advocacy of the rendezvous technique has been gaining ground. Rendezvous involves launching the final moon rocket and the passenger capsule in two or more segments, having them join together while in orbit, and from orbit launch themselves toward the moon. The alternative is to use one very large rocket to send the vehicle directly to the moon. A decision has been made to push about equally in both directions for the time being. Until now the major emphasis has been on the direct approach and the necessary development of a big rocket to carry it out.

On the jurisdictional question, the Air Force has been pushing hard for a greater role in the space effort. So far it has been getting no noticeable support from the Department of Defense, but a good deal of support from Lyndon Johnson, whose duties as vice president include the chairmanship of the Space Council. The details of the coming federal budget will give an idea of what success, if any, the Air Force has had in pressing its view that no useful line can be drawn between the military and civilian space programs, and therefore that nothing should be considered automatically unsuitable for development by the Air Force. The civilian Space Agency, of course, takes a different view of the situation.—H.M.

Overhead Costs: Intangibles Make It Difficult To Compute Cost of University Research

Officials of the University of Chicago reacted angrily last week to a report that the university may turn a profit under a new federal contract for operation of Argonne National Laboratory.

The possibility was stated in a New York *Times* report which revealed that the Atomic Energy Commission had agreed to give the university a "management allowance," in lieu of the overhead allowance provided for in the expiring contract. Under the old contract, the university received about $500,000 annually for the indirect, or overhead, costs incurred in operating the $50-million-a-year laboratory. The university has repeatedly complained, as have almost all institutions doing research for the government, that this overhead allowance is niggardly and fails to reflect a considerable portion of the "hidden" costs of research.

In negotiations for the new contract, the University of Chicago sought an overhead allowance of $1.6 million. This figure, according to university officials, was based on the general expansion of university activities since the contract was last under review, and on the university's contention that the AEC had been fairly miserly last time in its interpretation of indirect costs related to Argonne National Laboratory.

The AEC's accountants, however, saw justification for an increase of only $100,000 in the current allowance. The university then proposed that point-by-point accounting be abandoned, and that the university be given a lump allowance of $1.2 million. This proposal was accepted by the AEC, reportedly by a 3 to 2 vote of the commissioners. The attendant news report stated that the AEC "has adopted a policy opening the door for universities to make a profit on their management of the commission's national laboratories." To this, university officials reply that even the increased sum is inadequate and that the suggestion of profit is preposterous. They also point out that the University of Chicago is by no means the pioneer in receiving a management allowance from the AEC. In past years, this provision has been written into AEC contracts with the University of California, which operates Los Alamos Scientific Laboratory and the Lawrence Radiation Laboratory, and Associated Universities, Inc., which operates Brookhaven National Laboratory.

The differing points of view on overhead costs illuminate the fact that this computation is probably as much an affair of the heart as it is of the accountant's tape. Underlying the issue, in this and similar cases, are conflicting concepts of the nature of university research. Government budget officers, interested in making their funds go as far as possible, tend to view university research as something that, financially, at least, can be isolated from the overall university environment. University budget officials, seeking to make their funds go as far as possible, take a broader view of just how much indirect support the university environment affords specific research efforts.

The uncertainties of what constitutes justifiable overhead costs are matched by the uncertainties of what criteria should be applied in computing them. In theory, the basic document is an equally damned and praised Bureau of the Budget publication which recommends, but does not require, the application of certain standards. Standing aloof from the bureau's recommendations are the Department of Health, Education, and Welfare and the National Science Foundation. Health, Education, and Welfare limits its overhead costs on grants and contracts to 15 percent, a figure which is widely considered to be inadequate, but which strikes the fancy of Representative Fogarty, chairman of the appropriations subcommittee that passes on HEW funds. The National Science Foundation pays 20 percent, but there are indications that NSF is coming to the conclusion that this figure is too low, and it may provide for an increase in the near future.

Just what other departments and agencies pay is not easily arrived at. One government official who is familiar with the practices of a number of federal agencies contends that, for a given piece of research, a university could find itself receiving over 70 percent in overhead costs from the Department of Defense, 20 percent from NSF, and 15 percent from HEW.

The Bureau of the Budget guidelines are looked upon by many university officials as completely to their liking, and their fervent wish is that budget officers would take the guidelines to heart. In the 22 pages of specifications for computing costs, sufficient latitude is present to justify a happy agreement

between any generous government budget officer and any straitened university counterpart. The difficulty is that the two come to the bargaining table with differing interests. Not so pleased with the Bureau of the Budget guidelines are the budget officers of a number of universities, especially smaller ones, who look upon the document as an accountant's nightmare.

On the generally recognized indirect costs such as heat, light, janitorial service, and procurement of help, there is little disagreement. From there on, however, the possible interpretations lead some government budget officials to the conclusion that the universities are seeking to milk them, and university officials to the conclusion that some government officials are ignorant of what makes a university tick.

In the University of Chicago negotiations with the AEC, one matter of contention was the question of how much the AEC should pay in indirect costs for the support which the university library provides for Argonne Laboratory, which is some 35 miles away from the campus. It was the AEC's contention that the university library is of little significance in the operation of the laboratory, which has its own local library facilities. This interpretation of the library's relationship to Argonne sends despair through university officials, who find it difficult to convince cost accountants that a university cannot be dissected.

On an even more subtle point, the intangible, unascertainable support that one element of a university lends to another simply through the informal personal relationships that develop among its people, there is no convincing the cost accountants.

"How," asked one official, "can you explain the value that's derived from having people on a physics project in a position where they can consult with people in the mathematics department? There's no dollars-and-cents value that can be assigned to that. But it's indirect support, if anything is indirect support. When pennies are pinched on the work that a university does for the government, the result is belt tightening that can subtly affect the government work."

In support of their case for the intangible benefits that research derives from a university environment, university officials point out that profit-making firms holding government contracts frequently develop formal as well as informal relationships with nearby universities. The benefits flow both ways, of course, and defy cost analysis, but they support the contention that the presence of the campus is a plus for the researcher carrying out a specific government project.

Some government officials feel that universities tend to exaggerate the overhead expense involved in carrying out federally financed research projects, especially at large-scale research facilities, such as the AEC's national laboratories. These, they point out, are frequently located some distance from the main campus, and they have developed into largely self-contained units that require little support from the parent institution. In regard to on-campus, small-scale research projects, those skeptical of the universities' pleas argue that government money has brought unparalleled prosperity into university science. Like Representative Fogarty, who is skeptical of the claim that HEW's 15 percent limit is inadequate, they say that they do not notice any significant number of universities declining the opportunity to undertake government work, despite the size of the overhead allowance.

The question of a fair allowance draws various figures. Fogarty's committee was told last spring that a limited survey of small institutions placed their average overhead costs at 42 percent; larger institutions reported theirs at 34 percent. The National Science Foundation is preparing a study that is expected to offer a broader consensus.

In the meantime, the views of the universities are being coordinated and pushed for the first time in Washington through the Committee on Governmental Relations of the National Federation of College and University Business Officers. This organization is trying to get across a message that so far has received little attention. Although the Administration has paid lip service to the universities' pleas, the case for enlarging HEW's 15-percent overhead allowance got lost on the crowded and noisy route between the White House and Capitol Hill. The funds sought by the Administration for the HEW overhead increase were paltry in relation to overall research expenditures. And in the Senate-House conference on the measure, the Senators who had backed an increase showed no willingness to fight for their point. A more forceful presentation of the universities' case might have made a difference in the outcome.—D.S.G.

Civil Defense: The Confusion Will Not Be Easily Dissipated

The Administration's desire to chart a civil defense program for the nation was bogged down this week in the vast uncertainties that bedevil any attempt to foresee and prepare for the havoc of a nuclear attack.

One element of the program—a survey of existing structures that would offer fallout protection—was reported to be moving along; but in its insistence on individual and family efforts for survival, the Administration found that it had sown considerable confusion. The details on just what each household should do in behalf of its own survival have not yet been put forth by the Administration. Into the breach has stepped an array of experts with advice ranging from nothing to prescriptions for elaborate shelters. *Life* magazine reports that 97 out of every 100 persons can be saved through proper preparation; Tom T. Stonier of the Rockefeller Institute, reporting on behalf of the Scientists' Committee for Radiation Information, estimated that the fire storm produced by a 20-megaton blast at New York's Columbus Circle would kill 6 million of the city's 8 million residents. Additional lives, he said, would be lost in the city's suburbs.

While the debate is being carried on by nongovernmental parties, the Administration's civil defense planners are cautiously picking their way toward what will be the "official" government policy on civil defense. Their difficulties are illustrated by the fact that a civil defense booklet which is to be sent to every family has now been in preparation for about 3 months; until recently, it was expected that it would be completed this month, but in the Office of Emergency Planning it is now estimated that the publication will not be ready until December, possibly later. OEP officials say that before the booklet is sent to every household in the United States, it will probably be subjected to a pilot testing, which may well result in further changes and delays.

Regardless of the date of distribution, it is unlikely that widespread harmony will be achieved by any official design for coping with the unknown. From some critics of the Administration's slowness has come the happy thought that a few well-chosen statements would end public confusion

in this area. Among the planners, however, there is the knowledge that no matter how much wisdom they compress into the civil defense booklet, the uncertainties are such that an honest approach will not produce anything resembling *Life's* conclusions. And if an attempt is made to downgrade the destructiveness of nuclear weapons, the inevitable confrontation of well-founded, conflicting views will undermine public confidence in the entire program.

Further complicating the task of the planners is the fact that it must be conceded at the outset that for a vast number of people—those in an immediate target area—no preparation can be beneficial; while for those outside the target area, survival is predicated on a number of highly optimistic assumptions, including that of no follow-up attacks.

The caution with which the President is approaching the overall subject is illustrated by what he said at his news conference last week. In reply to a question on what could be done to dispel public confusion on civil defense, he stated that "it's very difficult in a large country, with varying problems of geography, with 180 million people, to suddenly organize a civil defense program. . . . I stated in July that we were going to send a book giving the latest information that we had to every household. . . . We are very conscious of the difficulties. We are very conscious of the desire of people to have accurate and precise information."

Whatever accuracy and precision may be achieved by the planners, confusion is, unfortunately, an inevitable by-product of any attempt to prepare the civilian population for the unknowns of nuclear warfare. The confusion is likely to be with us long after the booklet and the policy have been delivered.—D.S.G.

Last year the Supreme Court refused to judge Connecticut's birth-control law on the grounds that the law was not being enforced, and that nobody's rights were being infringed upon. The ruling followed well-established precedents intended to discourage unnecessary litigation. This month the law was invoked, for the first time in this century, against a birth-control clinic in New Haven, and a court ruling on the constitutional question now becomes almost inevitable.—H.M.

Announcements

A **dental clinic for emotionally disturbed patients**, or for individuals who have fears so severe that they are unable to undergo usual dental treatment, opened this month as an affiliate of the Columbia University School of Dental and Oral Surgery. The staff, in an effort to reduce unfavorable dental associations, will work in street clothes and use amnesic drugs, general anesthetics, and specialized equipment. (Dental Clinic, Grand Central Hospital, 321 E. 42 St., New York 17)

An installation for ground-based scatter radar explorations of **upper atmosphere and outer space** is being constructed by the National Bureau of Standards and the Peruvian Instituto Geofisico de Huancayo. The new Jicamarca Observatory will have a 6-million watt pulse transmitter and a 22-acre antenna, and will be used to measure the intensity of the earth's magnetic field, to observe radar echoes from the sun's corona and from solar gas clouds, to study small-scale irregularities in the outer atmosphere, and to search for radio stars one magnitude weaker than those observed to date. The observatory, located at a site 17 miles east of Lima, Peru, is expected to be operational in December 1961.

Training and career development opportunities in the U.S. Public Health Service's **mental health program** are outlined in *Careers in Psychiatry*, recently published by the National Institutes of Health. The booklet includes descriptions of locations, types, and major phases of the programs; methods of candidate selection; and the pay scale and residencies available. (NIH, Office of Research Information, Bethesda 14, Md.)

Iodine-125, a relatively new radioisotope previously available only in research quantities, is currently being produced at Oak Ridge National Laboratory for $1 per millicurie on a production basis. (ORNL, P.O. Box X, Oak Ridge, Tenn.)

A curriculum guide on establishing **electronics training programs** in secondary schools has been published by the Radio Corporation of America. The volume contains outlines of sample courses, a checklist of considerations in launching such a program, laboratory equipment requirements, and a description of available training devices. (RCA Audio Products, Meadow Lands, Pa. $2)

Grants, Fellowships, and Awards

Applications are being accepted for the 1962 Organization for Economic Cooperation and Development (OECD) **senior visiting fellowships in science and technology** (excluding social science, economics, psychology, pharmacy, and medicine). Candidates, to be nominated by scientific or technical institutions in the United States, its territories, or possessions, must be senior staff scientists, engineers, or mathematicians who (i) are citizens or nationals of the U.S. as of 2 April 1962; (ii) have full professional standing in the field with which the fellowship is to be concerned; and (iii) have at least 5 years of professional research or teaching experience. Recipients will spend from 8 weeks to 6 months studying new techniques and developments at research institutions, primarily in countries that are members of, or cooperating with, the OECD (Austria, Belgium, Canada, Denmark, France, West Germany, Greece, Iceland, Ireland, Italy, Luxembourg, the Netherlands, Norway, Portugal, Spain, Switzerland, Turkey, the United Kingdom, and Yugoslavia). Deadline: *5 January 1962*. (Fellowship Office, National Academy of Sciences, Washington 25, D.C.)

Applications are now being accepted for graduate research fellowships, assistantships, and scholarships in **forestry** for 1962–63. Research fellowships carry minimum annual stipends of $2100; 9-month assistantships, $1700–$2000; scholarships, $300. Deadline: *1 March 1962*. (Associate Dean for Graduate Studies, New York State University College of Forestry, Syracuse 10)

Applications are now being accepted for the 1962 Lalor Foundation awards given for research on **fertility** and the basic phenomena involved in the fundamental biochemical and physiological mechanisms that are concerned with the early stages of reproduction in various forms of life. The awards, ranging up to $8000 per year, will be given to members of university and college faculty and staff, with preference to

those who are under 41 years of age.

The foundation will also grant post-doctorate summer or short-term research awards, which will be limited to $1000 for single applicants (male or female); $1200 for a married man working at his home institution; and $1350 for a married man whose principal program is at another institution. Deadline: *15 January 1962*. (Lalor Foundation, 4400 Lancaster Pike, Wilmington 5, Del.)

Fifty Shell merit fellowships at Stanford University are available for **high school science and mathematics teachers** who wish to obtain advanced study in their teaching fields. The fellowships, awarded on a regional basis, provide full tuition for the 1962 summer session, board and lodging, transportation allowance (not to exceed $150), and a $500 cash stipend. Applicants must have a bachelor of science degree and a minimum of 5 years' teaching experience. Deadline: *4 January 1962*. (Paul D. Hurd, Shell Merit Programs, Stanford University, Stanford, California)

The 1962 North Atlantic Treaty Organization fellowships for the **study of science abroad** will again be administered by the National Science Foundation. Applicants, who must have a doctoral degree or equivalent experience, are encouraged to study in a NATO-member country, although consideration will be given to those planning to study elsewhere. Fellows will receive $5000 for full-year tenures and $3750 for the academic year, plus limited dependency and round-trip travel allowances. Deadline: *18 December 1961*. (Fellowship Office, National Academy of Sciences, Washington 25, D.C.)

Applications are now being accepted for the 1962 **foreign fellowships for medical students**, available to all students who have satisfactorily completed their junior year of medical education. The program, sponsored by Smith Kline & French Laboratories in Philadelphia, provides clinical experience abroad for an average period of 12 weeks. The amount of the grant is determined according to individual expense and need, varying with different programs and locations. Deadline for receipt of applications (to be obtained from school deans): *31 December 1961*. (Association of American Medical Colleges, 2530 Ridge Ave., Evanston, Ill.)

Applications are being accepted for grants-in-aid of research in **arctic and subarctic North America and Antarctica**. Proposals which include field studies are particularly welcomed. (Arctic Institute of North America, 1530 P St., NW, Washington 5, D.C.)

Applications are being accepted for the 1962–63 research fellowships in **psychometrics** leading to the Ph.D. degree. Fellows will be engaged in training and research with Princeton University's educational testing service on a part-time basis during the academic year and full-time during two of the summer months. Stipends are $3750 per year plus allowances for dependent children. Deadline for receipt of applications and supporting material: *5 January 1962*. (Psychometric Fellowship Program, Educational Testing Service, Princeton, N.J.)

Applications for the 1962–63 **National Science Foundation graduate and postdoctoral fellowships** are currently being accepted. Fellowships will be awarded in the mathematical, physical, medical, biological, and engineering sciences; and in anthropology, geography, psychology (excluding clinical psychology), sociology (not including social work), economics (excluding business administration), and the history and philosophy of science. Applicants, who must be U.S. citizens, are required to take the graduate record examinations which will be evaluated by appointees of the National Academy of Sciences–National Research Council. A brochure describing the fellowships is available from the National Science Foundation, Washington 25, D.C.

Deadline for receipt of applications: *5 January 1962*. (Fellowship Office, NAS–NRC, 2101 Constitution Ave., NW, Washington 25, D.C.)

The U.S. Public Health Service has published a brochure outlining **research and training grants in environmental health**—air pollution, environmental engineering and food protection, occupational health, radiological health, and water supply and pollution control. (Office of Resource Development, Bureau of State Services, PHS, Washington 25, D.C.)

Fellowships for **advanced training in health physics** for 1962–63, leading to the doctoral degree, are available through the U.S. Atomic Energy Commission. Applicants, preferably under 32 years of age, must have a minimum of 2 years' experience in health physics (exclusive of training), and should be currently working in the field. A stipend of $4000 will be awarded for the first year, and may be renewed for up to 3 years. Deadline: *1 February 1962*. (Fellowship Office, Oak Ridge Institute of Nuclear Studies, Oak Ridge, Tenn.)

The National Science Foundation is offering fellowships for **secondary school teachers of science and mathematics**. The fellowships, established to support summer study in the mathematical, physical, and biological sciences at institutions chosen by the fellows, will begin in 1962 and continue for a maximum of 3 successive summers. Applicants must hold a bachelor's degree or its equivalent, and have at least 3 years of secondary-school teaching experience. Stipends of $75 will be provided for each week of tenure, plus travel, tuition, and dependency allowances. Deadline: *5 January 1962*. Recipients, to be chosen by AAAS-appointed panelists, will be notified by 15 March. (Secondary School Fellowships, AAAS, 1515 Massachusetts Ave., NW, Washington 5, D.C.)

Courses

An international field institute for U.S. college and university **geology teachers** will be conducted in the Swiss Alps during the summer of 1962. The 8-week program, sponsored by the American Geological Institute under a National Science Foundation grant, will provide an opportunity for geological study of the Alps and adjacent field areas of France, Italy, and Austria, under the leadership of Swiss scientists. Participants will receive travel and subsistence allowances. Deadline: *1 February 1962*. (D. L. Blackstone, Jr., AGI-IFI-Alps 1962, c/o Dept. of Geology, University of Wyoming, Laramie)

The 3rd international course on **freeze-drying** will be presented from 17 to 28 July 1962 in Lyon, France. Lectures covering basic theory, research, and industrial applications will be delivered in both French and English by authorities from France, England, Germany, and the United States. (H. T. Meryman, Naval Medical Research Institute, Bethesda 14, Md.)

New Journals

Acta Neuropathologica, vol. 1, No. 1, June 1961. F. Seitelberger, Managing Ed., World Federation of Neurology. Springer, Heidelberger Platz 3, West Berlin, Germany. Irregular. Maximum price per volume, DM 180.

Bulletin on Bibliography, Documentation and Terminology, vol. 1, No. 2, May 1961. Department of Natural Sciences, UNESCO, Place de Fontenoy, Paris 7°, France. Free of charge.

Cahiers du Pacifique, No. 3, June 1961. Museum National d'Histoire Naturelle, 57, rue Cuvier, Paris 5°, France.

Journal of Psychiatric Research, vol. 1, No. 1, July 1961. S. S. Kety, Ed. Pergamon Press, Headington Hill Hall, Oxford, England. $20 per year.

Journal of the National Research Council of Thailand, vol. 1, No. 1, 1960. B. Kalakicha, Ed. Office of the National Research Council, Phya Thai, Rama VI Road, Bangkok, Thailand. Quarterly. $5 per annum.

National Institute of Animal Health Quarterly, vol. 1, No. 1, Spring 1961. S. Ishii, director. Extension and Information Service, National Institute of Animal Health, Kodaira-machi, Kitatama-gun, Tokyo, Japan.

Problems of Psychology (translation journal), vol. 1, No. 1, June 1961. N. O'Connor, Ed., Pergamon Press, Headington Hill Hall, Oxford, England. Quarterly. $12 per issue; $40 per year.

Quarterly Journal of Crude Drug Research, vol. 1, No. 1, 1961. E. F. Steinmetz, Ed. E. F. Steinmetz, 347 Keizersgracht, Amsterdam (Netherlands). $6.90 per annum.

Scientists in the News

Frederick N. Andrews, professor of animal physiology and head of the dairy department, has been named head of the recently formed department of animal sciences at Purdue, effective in January 1962. The new department combines the present separate departments of animal, dairy, and poultry science. **J. Holmes Martin**, head of poultry science at the university, will become assistant head and coordinator of genetic investigations in the department.

Robert F. Tebbe, of Gordon College in West Pakistan, is a visiting professor of chemistry for 1961–62 at Western Reserve University.

R. Karl Honaman, engineer and retired director of publications for Bell Telephone Laboratories, has been elected chairman of the board and chief executive officer of Floating Floors, Inc., in New York, producers of environmental facilities for data processing systems.

Carl E. Ludwig, professor of life science and chairman of the department at Sacramento (California) State College, is serving as guest research professor at the West German Zoologisches Institut der Universität Würzburg, during his 1961–62 sabbatical leave. **R. Darby**, assistant professor of life science, is acting chairman of the department.

Harvey A. Neville, chief administrative officer and former director of the institute of research at Lehigh University, has been appointed the ninth president of the university.

Morris E. Rose, former chief physicist at Oak Ridge National Laboratory, has joined the University of Virginia faculty as professor of physics.

Max Bender, senior research chemist with the American Cyanamid Company, has been appointed assistant professor of chemistry at Fairleigh Dickinson University.

Recently appointed associate professors in the University of Maryland's department of physics:

Rolfe E. Glover, III, of the University of North Carolina.

Gianni Quareni, of the University of Bologna.

Margaret Waggoner, of Stanford University.

Gaurang Yodh, of Carnegie Institute of Technology.

John T. Cowles, former professor of psychology and director of educational planning and health professions at the University of Pittsburgh, has been elected president of the Maurice Falk Medical Fund in Pittsburgh, Pa.

Raymond C. Grills, chemist, has been appointed to the newly created position of manager of new ventures in the Du Pont Company's film department. He was previously vice president and general manager of Ducilo S.A.I.C., the company's Argentine subsidiary.

Bert R. Boone, retired public health officer with the U.S. Public Health Service, has become assistant dean for research at Temple University Medical School.

Virgil Heniser, former science department head at the Thomas Carr Howe High School in Indianapolis, has been appointed a coordinator for school science at Indiana University.

Recent Deaths

Thomas H. Bartilson, 62; assistant director of the U.S. Department of Agriculture's animal husbandry research division at Beltsville, Md.; 9 Oct.

Edward L. Corey, 59; professor of physiology at the University of Virginia School of Medicine; 28 Apr.

Glen H. Hoppin, 81; engineer formerly with the U.S. Naval Ordnance Laboratory; 31 Oct.

Paul J. Kiefer, Sr., 74; retired professor of engineering and thermodynamics at the Naval Academy's postgraduate school; 4 Sept.

Roscoe E. Lewis, 57; former chemistry teacher and chairman of the social science department at Hampton (Va.) Institute from 1945 to 1953; 14 Sept.

Walter L. Lowry, 54; recently appointed dean of the school of engineering at Clemson College; 14 Sept.

Jeanette B. Obenchain, 85; former research associate professor of neurology at the University of Chicago and assistant professor of neurology at Western Reserve University; 29 Sept.

Vaux Owen, Jr., 34; geologist with the U.S. Geological Survey; 28 Oct.

Ernest Schwarz, 71; mammalogist and former lecturer in epidemiology at U.S. Naval Medical School in Bethesda, Md.; 23 Sept.

Edward H. Smith, 72; former director of the Woods Hole Oceanographic Institution (Mass.); 29 Oct.

Erratum: The annual index to products advertised in *Science* [134, 1253 (20 Oct. 1961)] contains an error in the listings for counters on page 1266. The counters now listed under "Counters, Whole Body," which were advertised at various times during 1961 by Packard Instrument Co., Inc., and Nuclear Chicago Corp., should, with one exception, have appeared under "Counters, Liquid Scintillation, Automatic." The exception is that the last entry for Packard Instrument Co. (15 Sept., 702) should remain under "Counters, Whole Body."

Erratum: In the announcement on the National Rehabilitation Research-Training Center [*Science* 134, 1351 (27 Oct. 1961)], the U.S. Public Health Service was erroneously credited with establishing the center. The center was established by the U.S. Department of Health, Education, and Welfare's Office of Vocational Rehabilitation.

Psychology's Role in Economic Development

Is there an identifiable personality trait that promotes or retards economic progress in societies?

Everett E. Hagen

It is a remarkable project for a scholar to attempt "to isolate certain psychological factors and to demonstrate rigorously by quantitative methods that these factors are generally important in economic development." This attempt David C. McClelland began 15 years or so ago. In **The Achieving Society** (Van Nostrand, Princeton, N.J., 1961. 527 pp. $7.95) McClelland weaves the many threads of his prodigious labors into a tapestry intended to portray his thesis comprehensively and persuasively.

Some persons, he indicates, are characterized in greater degree than others by the "achievement motive," and some are characterized in greater degree than others by what David Riesman has termed "other-directedness." The frequency with which these two characteristics are present in personality varies among societies. The rate of economic progress of a society tends to depend on their presence and depends very little on factors which other students of economic development have thought important. Moreover, we know what type of childhood environment causes the achievement motive to appear in an individual, and perhaps we also know what circumstances inculcate other-directedness; and we can exercise some limited influence on both. So the argument of the book runs. I am not convinced that McClelland's evidence supports all of his conclusions and recommendations, but I am thoroughly convinced of the importance of the analysis presented.

Apart from equating the achievement motive to "an inner concern with achievement," McClelland nowhere in the book defines it. Perhaps with scientific caution he would define it simply as that which is measured by the tests he administers. The person who is characterized by achievement motivation is more drawn to problems than another person, and he feels more satisfaction in the process of solving them (but not necessarily in the reward he may obtain by solving them). Social psychologists are in fair agreement that there is such an identifiable characteristic, that it operates largely in the individual's unconscious processes (so that the individual is apt to err in estimating the degree to which he possesses it), and that it can be measured with a certain degree of accuracy. Under laboratory conditions McClelland measures it convincingly by certain "projective tests" and demonstrates a high correlation with certain traits of behavior, but for the data used to compare the degree of achievement motivation present in different societies, he relies mainly on obtaining identical types of writing from them (for example, among the writings used are poetry, public funeral speeches, and third grade readers), from which he determines how often, per 100 words, achievement-related ideas, as rather rigorously defined, appear in each.

Scope and Method

He takes the world from the time of ancient Greece to the present as his laboratory. A brief discussion of two of his major studies will illustrate his method. Collecting second to fourth grade readers in use in 23 nontropical countries about 1925 and those in use in a larger number of such countries in 1950, he proceeded to evaluate the achievement motivation reflected in the stories prepared for school use in each country. As one measure of economic growth in each of the same countries from 1925 to 1950, he took gain in national income per capita (Colin Clark's estimates, expressed in "international units"). By the statistical method of simple correlation, he then computed the gain in per capita income that each country might have been expected to attain in view of its initial level of income. He regarded the amount by which the country exceeded or fell short of the expected increase as measuring its over- or under-achievement, and he found that the scores of the 23 countries for achievement motivation, based on the readers, correlated highly with their degree of over- or under-achievement. Similarly, the scores for achievement motivation in 1925 correlated highly with the degree of over- or under-achievement in increasing the production of electricity from 1929 to 1950, and achievement motivation in 1950 correlated highly with the degree of over- or under-achievement in the production of electricity from 1952 to 1958.

In studying the ancient world, McClelland used a broader time scale. He measured the achievement motivation expressed in the literature of Greece during three time periods: 900 to 475 B.C., 475 to 362 B.C., and 362 to 100 B.C. It declined steadily. Then, measuring Greece's economic prowess by the size of her trade area in the sixth, fifth, and fourth centuries, respectively, he found economic expansion from the sixth to the fifth centuries and contraction from the fifth to the fourth. The expansion, he concludes, was due to the high degree of achievement motivation found in the earliest period and the contraction to the subsequent decline in achievement motivation.

By similar methods, he finds similar relationships between achievement motivation and economic prowess in Spain in the late Middle Ages, in England from 1500 to 1833 (economic change lagged 50 years behind change in the need to achieve), in the United States between 1800 and 1950, and in Peru from 800 B.C. to A.D. 700. He adduces much other evidence as well, but these are some of the main pieces.

The author is professor of economics at Massachusetts Institute of Technology and senior staff member at its Center for International Studies.

Economics of Personality

In the materials he analyzed, McClelland also finds evidence concerning the relationship between other personality characteristics and economic prowess. His evidence casts doubt on various hypotheses occasionally suggested in the literature, but it convinces him that one type of social change is highly favorable to development. Economic development will progress if "the force which holds society together has shifted from tradition, particularly impersonal institutional tradition, to public opinion which helps define changing and functionally specific interpersonal relationships." In other words, change in a society from "tradition-directedness" to "other-directedness" is not merely a feature of advanced urban culture as Riesman suggests; it is an early change which portends economic development. Having uncovered this relationship, as he thinks, McClelland asks why it should be so; he finds reasons satisfying to him, which, for reasons of space, I shall not summarize.

Why should a high degree of achievement motivation lead to economic growth? Because, McClelland suggests, his studies of individuals that have high achievement motivation show that these individuals like to take moderate risks in which their abilities can influence the outcome, to carry on energetic and novel instrumental activity, to assume responsibility, to undertake actions in which success or failure can be measured, and to anticipate future possibilities. These are precisely the desires that can be satisfied in entrepreneurial business positions, and persons having high achievement motivation are therefore drawn to such positions.

How is achievement motivation inculcated in an individual? It depends, McClelland suggests, basing his suggestions on a considerable amount of empirical research by social psychologists, on childhood training. To summarize overly simply a chapter's discussion, achievement motivation will emerge in a son if his father is not dominating (if the father is, the son will learn not to exercise initiative), if his mother is highly "nurturant," and above all if she insists that, beginning at an early age, but not too early, the son accomplish things for himself and rewards him with love when he does so. Since the "Protestant ethic" stresses individual responsibility and should, McClelland thinks, lead parents to insist on early achievement by their children, he concludes that the association which Weber noted between the Protestant ethic and economic advance is a true causal one.

How then may economic growth be accelerated? By an ideological campaign and the emancipation of women, to overcome resistances to modernization; by building factories rather than cottage industry, in order to break up traditional patterns; by introducing widespread use of motors, to interest men in new things; and by improving transportation and communication, creating a free press, and introducing group play in schools and elsewhere, to create other-directedness. He has fewer suggestions for the inculcation of achievement motivation. Change in the educational system is of doubtful help. One study suggests that talking to a man about his fantasies, and thus increasing his achievement motivation, improves his subsequent performance. Lastly, McClelland recommends that the United States government subcontract to American business enterprises the job of providing technical aid to low-income countries. The business enterprises, he suggests, will send men with high achievement motivation, and these men may set manpower standards for the companies being aided, which would bring indigenous men who have the highest achievement motivation into effective roles.

Evaluation

The work is open to criticisms of several types. First, some of the statistical methods and deductions leave something to be desired. As noted above, McClelland calculates a simple regression between two variables, then a second between achievement motivation and deviations from the regression line, a procedure which gives spurious results if the achievement motivation and the variable first used are correlated, as they almost certainly are in this case. In his introductory chapter, he uses simple correlations to test the association of various factors with economic growth, whereas multiple correlations are surely called for. He makes a variety of conversions of data to forms he finds more convenient, without, it seems to me, adequately justifying the procedure. Lastly, not all of his historical data fit his theory, unless he assumes no lag in the 20th century between the presence of the achievement motive and its effect on economic growth; in his study of England, a lag of 50 years; and in his study of ancient Greece, a lag of some 300 years. He offers no explanation of the differences. (Conceivably they are justified.) No one who knows McClelland's work would have other than the highest respect for his scrupulous professional honesty, but there are unconscious biases, and one wonders how much weaker the evidence would look if an equally honest man, unconvinced of McClelland's thesis, took the various sets of raw data and analyzed the same relationships. A workable model of life is probably more complex than McClelland's, but there is evidence in addition to that which he presents in this book to suggest that he has hold of an important aspect of the truth.

Secondly, the theoretical structure for the analysis of personality is somewhat inchoate. The evidence concerning the relationship between childhood environment and need for achievement is convincing, within its limited scope, but in much other discussion of personality characteristics one finds only the most casual attention to whether the characteristics being analyzed could coexist in an individual. His discussion of how to influence personality suffers from the same neglect of the modern theory of personality and its formation. Great controversies remain in this field, but it is no longer a field in which recommendations are justified without reference to basic theory.

Lastly, the book lacks style. A book in which there are occasional sentences like the following needs editing: "Apparently we have here stumbled across, in quite a roundabout way, a fundamental value attitude. . . ."

Yet this is a book of ideas and evidence that cannot be ignored. Too many economists have believed that low-income countries fail to develop simply because they are too poor to finance development or have markets too small to induce investment; too many scientists or engineers have thought that, by the injection of a little scientific method or a little system analysis, the problem could readily be solved; and so on. No such person with an open mind who reads this book, or who reads selected chapters that interest him, will be quite as naive thereafter.

Medical Americana

The Toadstool Millionaires. A social history of patent medicines in America before federal regulation. James Harvey Young. Princeton University Press, Princeton, N.J., 1961. xii + 282 pp. Illus. $6.

"Somebody buys all the quack medicines," wrote Oliver Wendell Holmes, "that build palaces for the mushroom, say rather, the toadstool millionaires." This tragicomic quip supplies a title with appropriate overtones for the definitive, interesting book by James Harvey Young, chairman of the history department at Emory University. Like Holmes' epigram, Young's book conveys significant information without being dull. It should satisfy the reader lured by its main title, just as it should fulfill the promise of its subtitle for the more serious seeker.

The book ought to be in public and college libraries, for I think anyone who wants to read a single book on the social history of patent medicines would do well to read this one. Even those already rather knowledgeable on the subject will find it valuable.

The author divides his account of American patent medicines before 1906 into five parts:

About a third of the book, devoted to the early period, covers English patent medicines in Colonial America, the American beginnings—under the stimulus of such colorful characters as Thomas Dyott and Samuel Thomson—the relationship of the press to nostrum peddlers, and the early voices of criticism.

The heyday of the nostrum kings, before federal regulation (occupying about a fourth of the book), is viewed in relation to the Civil War and its aftermath, outdoor advertising, almanacs published under patent-medicine auspices, and the quackish use of the germ theory. Here we meet such "toadstool millionaires" as William Swaim, Benjamin Brandreth, Henry T. Helmbold, and David Hostetter.

A third part of the book (about 14 percent of the total) discusses promotional methods and psychology, including the techniques of medicine shows. Then we follow the rising tide of criticism against excesses (about 15 percent), which culminated in the Federal Pure Food and Drugs Act of 1906. A factual epilogue (about 5 percent of the total) permits the reader to form an impression of the rather massive reform that occurred during the ensuing half century.

Throughout the book the author draws upon a wide range of primary, and secondary, sources. Neither he nor the publisher tries to hide the precise and judicious documentation. In addition to the footnotes, an admirable bibliographic essay (7 pages) and an adequate index enhance the reference value of this readable book.

Young's book takes a clear lead over Stewart Holbrook's *The Golden Age of Quackery* (Macmillan, New York, 1959) through the documentation and wider range of sources, a more mature historical style, and a better index. Both books are similar in length, scope, and time span, but they are organized differently.

A sumptuous pictorial supplement to *The Toadstool Millionaires*, rather than a competitor, may be found in Gerald Carson's new book, *One for a Man, Two for a Horse* (Doubleday, Garden City, N.Y., 1961), which has as its subtitle "A pictorial history, grave and comic, of patent medicines." In Carson's volume we see the old style nostrum hucksters' rolling and redolent phrases in their original typography and pictorial setting.

Yet it is *The Toadstool Millionaires* that gives us the picture most memorable, and worth remembering. It is a historical picture that moves and flashes color, leaving a sense of the futility of free enterprise misdirected and of medication misused in hands that achieve "success" more by exploiting than by mitigating our vanities and afflictions.

GLENN SONNEDECKER
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Sourcebook

Biochemists' Handbook. Compiled by 171 contributors. Cyril Long, Ed. Van Nostrand, Princeton, N.J., 1961. xxii + 1192 pp. Illus. $25.

Truly a superb synthesis of contributions by authorities in their respective fields, this book is more than a handbook; it is a portable, concisely written encyclopedia of factual biochemical information. It has many useful tables of data, but more important, it also has unembellished, critical discussions of facts and principles. More specifically, the book has six main sections and an excellent index.

"Chemical Data." Here, in addition to tabulations of physicochemical data and the composition of buffers and salt solutions, there are discussions of physicochemical topics and procedures.

"Data on Individual Enzymes." Following a brief discussion of enzyme kinetics, nearly 300 enzymes are individually considered, and references to pertinent original papers are given.

"Metabolic Pathways." The pathways, as elaborated through 1959, for carbohydrate, lipid, and protein utilization and biosynthesis are verbally and diagrammatically presented. With these summations available for reference, extensions and changes as they appear in current journals will be more understandable and appreciated.

"Chemical Composition of Animal Tissues and Related Data." Anyone who has sought through the literature for quantitative data on the composition of various tissues will be sincerely grateful for the comprehensive tabulations in this section.

"Chemical Composition of Plant Tissues and Related Data." The thoroughness with which this volume covers the field is evidenced by the fact that plants are included.

"Physiological and Nutritional Data." The composition of foods, the effect of disease on the chemical composition of human blood, and the determination of the intra- and extracellular chemical components in tissues without disorganization are a few of the subjects considered in this section.

The index is excellent and usable, and by using it, one can quickly find the desired information on a point of interest. A further important feature of the book is the comprehensive bibliography. The references pertaining to a particular subject or table follow the discussion or table.

Instead of expounding on the merits and probable usefulness of the book I suggest that those whose interest is in biochemistry, physiology, and allied disciplines sample the contents for themselves. It will be a pleasant experience. I recommend the handbook without hesitation.

D. DZIEWIATKOWSKI
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Smirnov's Treatise Abridged

Linear Algebra and Group Theory. V. I. Smirnov. Revised, edited, and adapted by Richard A. Silverman. McGraw-Hill, New York, 1961. x + 464 pp. Illus. $12.50.

This book represents a selection of material from V. I. Smirnov's encyclopedic six-volume *Course in Higher Mathematics*. The first part of the book deals with linear equations and determinants and gives a good treatment of simultaneous linear equations using determinants. Part 2 gives a fairly exhaustive treatment of matrix theory, using extensively the results of determinants and linear equations from the first part. The material given includes the reductions to the various canonical forms; eigenvalues; orthogonal, unitary, and Hermitian matrices; covariance, contravariance, and tensor algebra. Numerous applications are discussed, including linear differential equations, Jacobians, and small oscillations.

Part 3 is on group theory and is the most valuable part of the book, for the material in the first two parts is fairly standard and easily available from many sources, while the material on group theory is not readily accessible to the American student. The various notions of group theory are introduced, but the author is primarily interested in the classical groups, particularly the rotation and Lorentz groups. The material includes representations (including the connection of representations of the rotation group with Laplace's equation), infinitesimal transformations, and invariant integration.

The topics chosen for emphasis are those that are of importance in applied mathematics and theoretical physics, and the style is such that the theoretical physicist or engineer will feel at home reading this book. One must also agree with the editor that, despite this, there is nothing in the volume the pure mathematician can ignore.

I do differ with Smirnov in taste about the presentation of linear algebra and matrix theory: The author, like most Russian textbook writers, prefers a treatment that is very concrete and computational, intimately bound up with coordinates and making intensive use of determinants. The linear algebra and geometric interpretations seem to come in by the side door, and the reader must look to other books for the chaste elegance of the abstract approach to linear algebra with its geometric flavor and largely coordinate-free treatment. It is possible to overdo the abstract approach, however, and Smirnov's handling of tensor algebra is refreshingly simple.

Silverman is to be congratulated not only for the smoothly reading translation but also for the exercises he and a number of collaborators have collected and constructed for the English edition of this volume. They are excellent and range from elementary ones that illustrate points in the text to sophisticated ones that explore areas beyond those considered in the text.

HALSEY ROYDEN
Department of Mathematics, Stanford University

To the Western Sea

The Natural History of the Lewis and Clark Expedition. Raymond Darwin Burroughs, Ed. Michigan State University Press, East Lansing, 1961. xii + 340 pp. $7.50.

Lewis and Clark's contribution to American natural history, judged "slight" by some commentators, in the words of Elliott Coues brought about our "first acquaintance with a large number of species." No experienced scientist was attached to the expedition, but Lewis exerted himself in observing and collecting natural history objects. The loss of some collections during the journey and the subsequent destruction of others (in P. T. Barnum's museum! and elsewhere) can only be regretted. In this volume Burroughs has prepared a card catalog in book form of the vertebrate populations encountered, from bears and buffaloes down to *Bufo*. The Lewis and Clark *zoological* record (the "natural history" of the book's title is blind in its botanical eye) is listed chronologically, with each quotation geographically localized for each species. These quotations are laced together with Burrough's commentary and with useful reports from explorers of the period: Bradbury (but not Nuttall), Prince Maximilian—consistently misspelled—and Townsend (but not James, or Say, or Drummond via Richardson). Burroughs also provides a 50-page introduction which amounts to a condensed diary of the expedition; a quantitative summary of the "game killed"; appendixes of archival materials relating to the expedition; chapter notes; and an index. It is unfortunate that the vernacular names used by Lewis and Clark, such as lark-woodpecker, are not indexed. Warning: parentheses replace square brackets in quotations from Thwaites and others. Many notable zoological studies—for example, Harry Harris's work on the California condor and Samuel Rhoads's annotated edition of Ord's *North American Zoology*—have been overlooked.

The crowded stage of natural history in Jeffersonian America, now reasonably well documented, is only partially unfolded in this book. There were Lewis's death, General Clark's involvement in Missouri Territory, the bankruptcy of the Philadelphia bookseller, and Professor Barton's procrastination. Jefferson's frustration over the delayed publication of the expedition's scientific results was matched only by the public's clamor to learn of the discoveries. Meanwhile, Alexander Wilson published the "new" birds and Rafinesque described three mammals without benefit of specimens. Professional conflicts broke out between George Ord and Richard Harlan, and veiled silence separated Harlan and Godman. Aside from incidental mention, Barton, Godman, Harlan, Ord, and Rafinesque are hardly noticed, though they were all players filling key roles in the thrilling drama of Lewis and Clark's crossing to the Western Sea.

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Interdisciplinary Approach

Interfacial Phenomena. J. T. Davies and E. K. Rideal. Academic Press, New York, 1961. xiii + 474 pp. Illus. $14.

This is a well-written monograph, which presents a modern treatment of a fairly wide range of phenomena associated with interfaces of interest to chemists, chemical engineers, physicists, and biologists. It is organized in the form of eight rather long chapters entitled "The physics of surfaces"; "Electrostatic phenomena"; "Electrokinetic phenomena"; "Adsorption at

liquid surfaces"; "Properties of monolayers"; "Reactions at liquid interfaces"; "Diffusion through interfaces"; and "Disperse systems and adhesion." As might be anticipated from authors who are well known for their outstanding work in colloid and surface chemistry, the material is soundly developed and written with authority, and the literature is well covered. The book, moreover, is unusually good as monographs in colloid chemistry go, in that the authors have taken pains to provide a fuller thermodynamic treatment than is commonly given.

Biologists and biophysicists will find much to interest them in chapters 4, 5, 6, and 7, which deal with phenomena that are characteristic of many biological systems, particularly of those in which diffusion across interfaces is important. Chemical engineers will find much that is of value in the chapters dealing with electrical effects, aerosols, emulsions, foaming, and friction.

References to the literature are collected at the end of each chapter, and the indexing is of a high quality. The line drawings used as illustrations are clean and attractive, but there are a few half-tones that leave something to be desired in crispness. I do not know whether this is due to the method of reproduction or to the quality of the original photographs.

The price of the book, $14, is certainly high; regrettably, this is characteristic of most monographs these days. Despite its price I strongly recommend it to those readers who are interested in surface chemistry.

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Miscellaneous Publications

(Inquiries concerning these publications should be addressed, not to Science, *but to the publisher or agency sponsoring the publication.)*

Australia. Commonwealth Scientific and Industrial Research Organization. **Bulletin**, No. 283, "The ecosystem of the coastal lowlands ("Wallum") of southern Queensland," J. E. Coaldrake, 148 pp., map. **Research Review** (for the year ending 30 June 1960), 418 pp. CSIRO, Melbourne, 1961.

Belgium. Institut Royal Météorologique **Publications**, Series B, No. 33. "Un Hygromètre de grande sensibilité," S. de Backer. The Institute, Brussels, 1961. 10 pp.

Canada. Dominion Observatories, Victoria. **Publications of the Dominion Astrophysical Observatory**. vol. 11, No. 16, "Curve of growth of C_2 absorption bands applied to the problem of the C^{12}/C^{13} abundance ratio," John L. Climenhaga, pp. 307–337, $0.25; No. 17, "The light-ratio and secondary spectrum of the eclipsing binary zeta *Aurigae*," E. K. Lee and K. O. Wright, pp. 339–351; No. 18, "Some spectroscopic observations of the supergiants 67 *Ophiuchi, 55 Cygni and* x^2 *Orionis*," Anne B. Underhill, pp. 353–361. Department of Mines and Technical Surveys, Ottawa, Canada, 1960.

Canada, National Research Council and Medical Research Council. NRC No. 6390. **Report on University Support, 1960–61.** Natl. Research Council, Ottawa, Canada, 1961. 123 pp. $0.50. Total research support by the councils at Canadian universities, $10,477,031 (an increase of $1.11 million over the previous year); direct support for science and engineering, $7,169,402 (82 percent for research grants to approximately 800 university staff members and the remainder for more than 800 graduate scholarships and fellowships. Medical research awards totaled $2,307,467 (300 research grants and support of 52 medical research fellows and 20 research associates). Indirect support (publication of scientific journals, contributions to scientific organizations and conferences, and administration of the program), $1,000,162.

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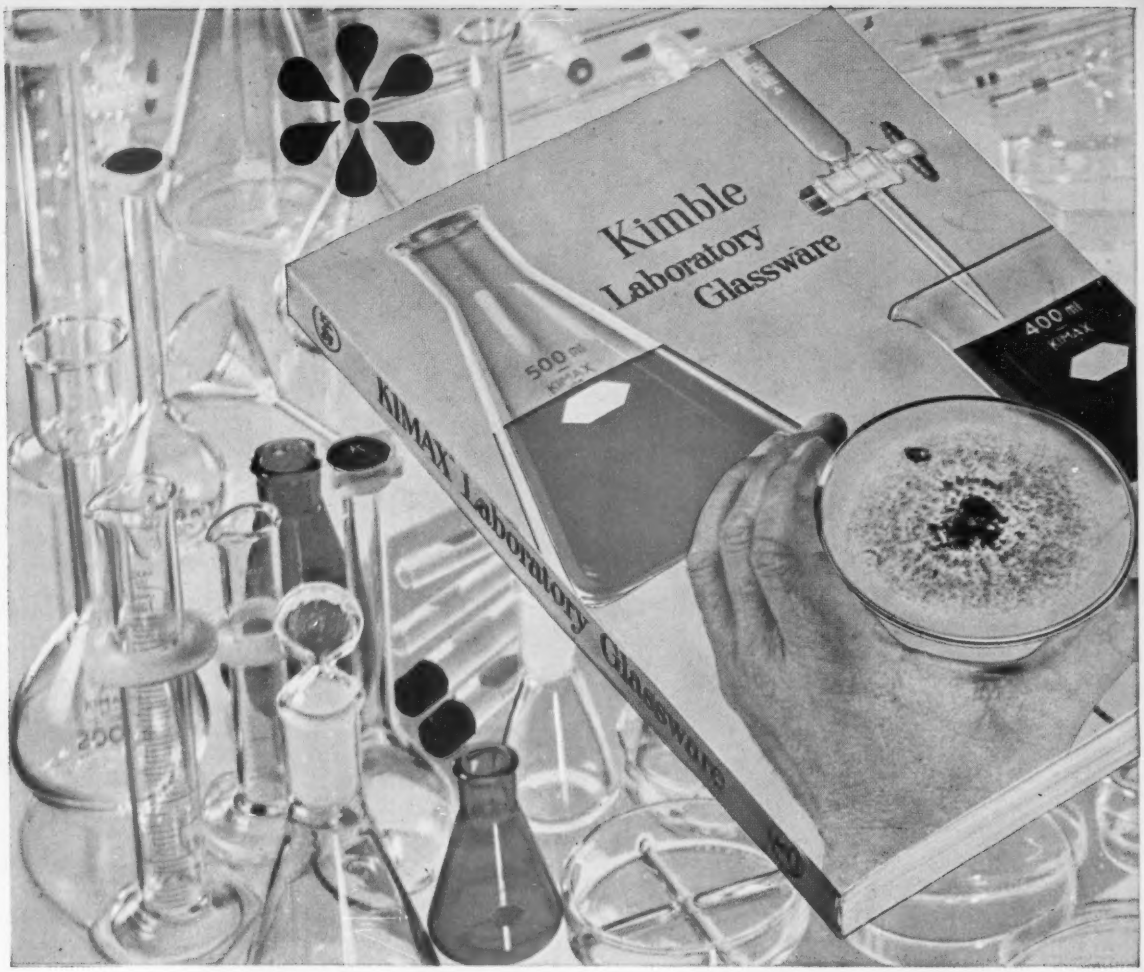

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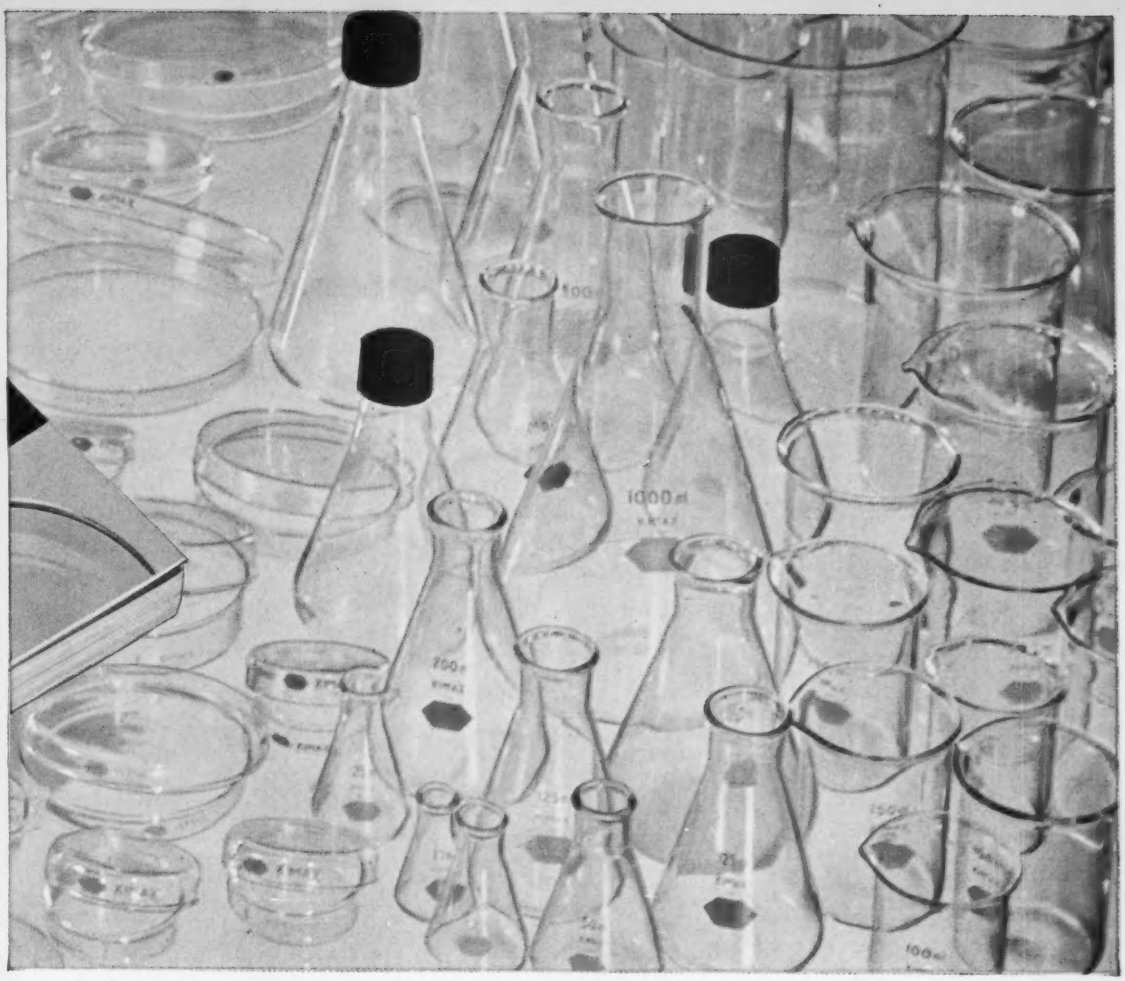

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Reports

Depressant Agent from Walnut Hulls

Abstract. Crushed unripe walnut hulls (*Juglans nigra*), when extracted with ether, yield an extract which sedates or at least depresses the movements of *Daphnia magna*, leopard frogs, perch, catfish, goldfish, mice, rats, and rabbits. One purified depressant compound, 5-hydroxy-1,4-naphthoquinone (juglone), has been isolated and tested on most of these species.

Crushed unripe walnut hulls (*Juglans nigra*) have been used for generations in various types of folk medicine, including treatment of fungus infections (*1*). In certain regions of the United States fresh walnut hulls are employed illegally to immobilize fish, and consequently take them from small streams and impoundments. The fish gradually lose equilibrium and awareness to changes in environment, and finally can be caught by hand. When placed in fresh water, many of these animals seem to recover fully. The use of walnut hulls in folk medicine and as a depressant of fish initiated our interest in extracting the active principle from green walnut hulls, testing it on different species of fish, and assessing its effects on several other species of animals.

After using several extractive solvents—including water, acetone, ethyl alcohol, chloroform, diethyl oxide, and petroleum ether—diethyl oxide (ether, U.S.P.) and petroleum ether were judged the two best solvents for extracting the active principles from fresh, finely ground walnut hulls. After the hulls had been macerated in ether, the solvent was allowed to evaporate at room temperature, leaving a dark, scaly residue. One kilogram of the fresh hulls extracted with 1.4 kg of ether yielded 2.13 g of residue. This residue produced the typical depression in young yellow perch (*Perca flavescens*), channel cat fish (*Ictalurus punctatus*), and goldfish (*Carassius auratus*). All of these fishes could be depressed markedly by the water-soluble fraction from 7 to 15 mg of the dried ether extract per liter of tap water. Perch were the most sensitive and goldfish the most resistant of the fishes tested. The small amount of extract used in these tests produced no measurable effect on the *p*H or oxygen content of the water.

A study was made also to determine whether this material would be specific for fishes or would have a similar effect on more primitive organisms (*Daphnia magna*) and more highly developed animals (frogs and mammals). Daphnia were immobilized and, if not placed in fresh water, would die when exposed to approximately the same concentration that was lethal to perch. The water-soluble fraction was dissolved in saline (0.7 percent) and injected into frogs. The frogs became quiet and recovered in a few hours, providing the dose did not exceed 1 mg/g of body weight. Albino mice and rats also were sedated after intraperitoneal injection of this substance dissolved in corn oil.

Attempts are being made to separate the sedative principles from this ether extract. One purified compound, 5-hydroxy-1,4-naphthoquinone (juglone), has been isolated to date. This juglone was separated from the crude ether extract by sublimation and then identified by melting point, infrared spectrophotometry, and crystalline studies by comparing it with known samples of synthesized 5-hydroxy-1,4-naphthoquinone. One gram of the crude ether extract yielded 0.156 g of the 5-hydroxy-1,4-naphthoquinone. Although it has been known for years that juglone occurs in various species of the walnut tree (*2*), published work on the pharmacological actions of this naphthoquinone does not include a sedative effect.

Our purified 5-hydroxy-1,4-naphthoquinone was tested on goldfish ($LD_{50} \cong 0.2$ mg/liter of water in the aquarium), mice ($LD_{50} = 0.25$ mg/100 g of body weight), and rats, and was found to have a calming or sedative effect in all of these species. Rabbits were injected intravenously with 0.07 mg of juglone (in 5-percent glucose solution) per kilogram of body weight. This resulted in tranquilization and general quietude of the animals for a period of 2 to 3 hours. Although sedation is produced by quite small amounts, the toxicity is such that profound sleep cannot be produced with less than lethal doses in these mammals.

Although the purified juglone produces sedation, there seems to be a difference between the quality of depression produced by the crude material and that produced by juglone. This suggests the presence of compounds other than juglone which may have synergistic action (*3*).

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THEODORE K. AUYONG
Department of Physiology and Pharmacology, University of Missouri School of Medicine, Columbia

References and Notes

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2. A. B. Massey, *Phytopathology* **15**, 773 (1925); E. F. Davis, *Am. J. Botany* **15**, 620 (1928).
3. This research was supported in part by National Institutes of Health grant MY-4295 (R1).

24 July 1961

Instructions for preparing reports. Begin the report with an abstract of from 45 to 55 words. The abstract should *not* repeat phrases employed in the title. It should work with the title to give the reader a summary of the results presented in the report proper.

Type manuscripts double-spaced and submit one ribbon copy and one carbon copy.

Limit the report proper to the equivalent of 1200 words. This space includes that occupied by illustrative material as well as by the references and notes.

Limit illustrative material to *one* 2-column figure (that is, a figure whose width equals two columns of text) or to *one* 2-column table or to *two* 1-column illustrations, which may consist of two figures or two tables or one of each.

For further details see "Suggestions to contributors" [*Science* **125**, 16 (1957)].

Proof of an Adaptive Linkage Association

Abstract. Linked X-chromosome inversions of an eastern woods fly, *Drosophila robusta*, occur in two different nonrandom arrays. Since only one can be the nonrandom condition expected on the approach toward random equilibrium, at least one of the observed arrays must have an adaptive basis.

It is fashionable in modern evolutionary genetics to state: "The raw materials of evolution arise by mutation and recombination" and then to proceed to discuss how alleles may change frequencies under directional or nondirectional forces. Very little attention has

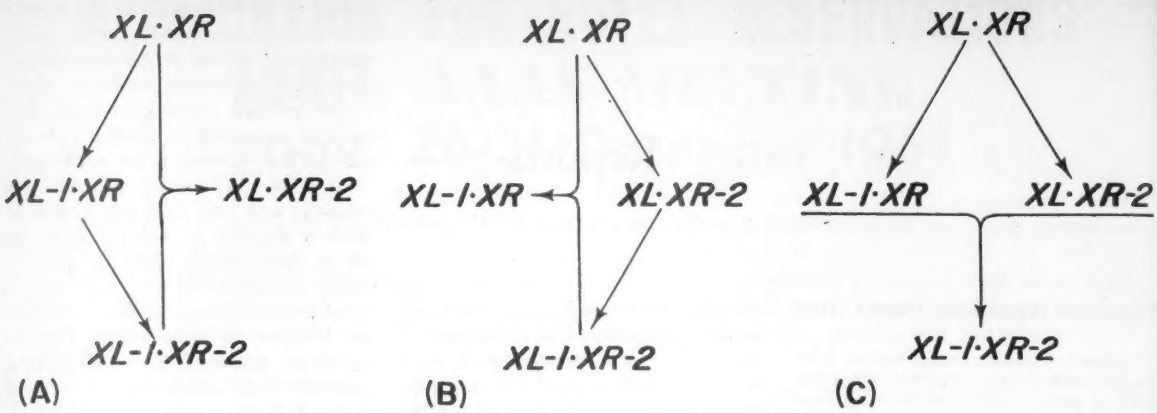

Fig. 1. Three possible pathways of linkage phylogeny (see text).

been paid to the question of how combinations of alleles produced by recombination—and surely few if any major adaptions have been produced by single loci—are incorporated into the genome. Especially lacking have been empirical studies of linkage situations. Undoubtedly the mathematicians of genetics early discouraged such studies by demonstrating that linked combinations would disintegrate to random frequencies unless selection could overcome the crossover rate. Many a geneticist has concluded that crossover rates are usually so large that only the accident of close proximity of loci (by translocation or other shifts of arrangement) or abandonment of sexual reproduction could achieve the conditions for effective selection for linkage combinations. Were linked loci encountered in a nonrandom condition, other geneticists probably realized, one could not readily distinguish whether the observed data represented an adaptive development or merely a stage in the mathematically predicted breakdown of the linkages to randomness.

The latter was my predicament when I wandered innocently into this problem. Studying the linked gene arrangements (chromosomes varying by paracentric inversions) in Blacksburg, Va., populations of *Drosophila robusta* Sturtevant, I found three different nonrandom associations in the same population (*1*). In spite of circumstantial evidence pointing to an adaptive basis for the associations, the doubt remained—that is, the doubt that they were merely historical relics on their journey toward random equilibrium. Data from a *D. robusta* population in the Great Smoky Mountain National Park near Gatlinburg, Tenn., prove, however, that at least one of the associations is adaptive.

The Blacksburg and Gatlinburg populations contain appreciable, fairly similar, quantities of two widespread gene arrangements of the left arm of the X-chromosome, *XL* and *XL-1*, of the two right-arm arrangements, *XR* and *XR-2* (*2*), and of all of the four possible combinations between them. In Table 1 the numbers of the combinations in two woods near Blacksburg and in a woods at a 2000-foot elevation near Gatlinburg are compared with the number expected in each sample on the assumption of randomness. Whereas both of the Blacksburg populations contain a highly significant excess of the so-called "coupling" combinations, *XL·XR* and *XL-1·XR-2*, and corresponding deficiency of the "repulsion" types, *XL·XR-2* and *XL-1·XR*, the Gatlinburg flies exhibit the reverse situation: excess of the "repulsion" types and deficiency of the "coupling" ones. The differences from expected are highly significant. An association of the Blacksburg type apparently exists also in a Lexington, Ky., population (*1*) and, in an extreme form, in a population from the Piedmont region of Virginia (*3*). In 1959 the Gatlinburg result was repeated at the 2000-foot woods, and this association pattern was found in collections from other locations near Gatlinburg and from the Blue Ridge Mountains of Georgia (*3*).

Table 1. Actual (*a*) and expected* (*e*) numbers of X-chromosomes in adult *D. robusta* from two woods near Blacksburg, Va. (1950–55), and from a woods at a 2000-foot elevation in Great Smoky Mountains National Park near Gatlinburg, Tenn. (1958).

Chromosome	Blacksburg				Gatlinburg			
	Crumpacker Woods		Heth Woods		April 1958		August 1958	
	a	*e*	*a*	*e*	*a*	*e*	*a*	*e*
XL·XR	247	212.4	197	162.2	7	15.0	47	87.5
XL·XR-2	553	587.6	403	437.8	30	22.0	160	119.5
XL-1·XR	214	248.6	221	255.8	38	30.0	186	145.5
XL-1·XR-2	724	689.4	726	691.2	36	44.0	158	198.5
Total	1738	1738.0	1547	1547.0	111	111.0	551	551.0
Chi-square†	14.2‡		16.7‡		10.8‡		52.0‡	

* Expected on the assumption that left- and right-arm arrangements are independent. † Chi-square testing goodness-of-fit of *a* to *e* in each sample; each has 1 degree of freedom. ‡ Highly significant ($P < .01$).

The exact phylogeny of the gene arrangements of *D. robusta* is not known, but *XL* and *XR* are probably ancestral to *XL-1* and *XR-2* (*4*). Hence the linkage phylogeny could have followed three pathways. In the first two (Fig. 1, *A* and *B*) both coupling types appeared, followed by (bracket) the formation of the missing repulsion type by crossing over between them. In the third (Fig. 1*C*), both repulsion types appeared independently, followed by formation of the missing coupling type by crossing over.

Schemes *A* and *B* may be termed "couplings first" and scheme *C* "repulsions first." Under any scheme the fourth linkage would be produced by crossing over in the available double-

heterozygotes, and until it achieves its random frequency the population would present a nonrandom association. Once formed, incidentally, the two "couplings first" schemes are indistinguishable from one another, because, under the 2-by-2 contingency table, the two coupling or two repulsion types show equal deviation from expected, no matter which single linkage is responsible for the deficiency or excess. Similarly, the arguments do not depend on the assumption that *XL·XR* is the oldest combination. *XL-1·XR-2* may be substituted for *XL·XR* in any scheme; having a repulsion linkage ancestral means merely that the possible phylogenies consist of two "repulsions first" alternatives and one "couplings first" instead of the reverse.

The crucial point is, however, that only one of the possible phylogenies could have occurred, for, unlike point mutations, which presumably recur again and again in the species phylogeny, inversions are probably unique events. For one thing, spontaneous chromosome aberrations are much rarer than spontaneous mutations. In addition, the chances of repeating identical breaks necessary for an exact copy of an inversion are infinitesimal. It follows that only one kind of nonrandom association attributable to the historical process of building up the fourth linkage combination by crossing over is possible, either one in which the coupling types are deficient, the phylogeny having been "repulsions first," or else one in which the repulsion types are deficient, the phylogeny having been "couplings first." This means that at least one of the associations, the Blacksburg type or the Gatlinburg, is *not* the historical association. It must be a newly evolved, adaptive one, since natural selection, or at least selective migration, must be postulated in order to maintain a linkage association in the face of the randomizing tendency of recombination.

This demonstration achieves the other side of the coin of the typical evolution problem. Usually the adaptive trait is noticed, and the surmise is made that it resulted from selection for interacting loci, number and location unknown. Here the interacting loci are known to be linked, but the adaptive traits produced by their interaction are unknown. Some evidence exists, however, that in Blacksburg, at least, the X-chromosome association is involved in *D. robusta's* seasonal adaptations to the environment (*5*). It is also likely that selection for the associations has been accompanied by selection for chiasma suppression. The region between the right- and left-arm arrangements available for crossing over includes more than 20 percent of the X-chromosome euchromatin, yet less than 1 percent crossovers (*6*) are obtained (*7*).

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13 February 1961

Effect of Verbalization on Reversal Shifts in Children

Abstract. Two questions were asked: (i) Would naming stimuli in a discrimination reversal influence the performance of 4- and 7-year-old children, and (ii) if so, would the influence be different for these two age groups? The results indicate a positive answer to the first question and an equivocal answer to the second.

There is considerable current interest among psychologists in the behavioral analysis of processes that mediate between the external stimulus and the overt response. One method developed for such analysis is the reversal-nonreversal shift technique (*1*), which was adapted in the following manner to the present research. Forty-eight nursery school children (mean age, 56 months) and 48 second-grade children (mean age, 91 months) were required to learn two successive discriminations. The stimuli, two-dimensional squares, varying in area (1 in.^{2} and 3 in.^{2}) and brightness (black and white), were presented in a portable discrimination apparatus which displayed two squares simultaneously. The child chose one of them by pressing a lever that pointed at his choice. A marble served as reinforcement. As illustrated in Fig. 1, the first discrimination presented one stimulus pair that differed simultaneously on two dimensions. The second discrimination presented this same pair with the reinforcement pattern reversed or another pair that also differed simultaneously on the same dimensions; the two pairs were presented in random alternation. Stimulus preferences were controlled by suitable counterbalancing.

The major experimental variable was the kind of verbal label the children were instructed to apply to the correct stimulus during the initial discrimination. These labels, which were always appropriate to the first discrimination, could be arranged to be descriptive of either the relevant or irrelevant dimension in the second discrimination. For example, if a child was trained to be a relevant verbalizer, he was presented with the reinforcement pattern illustrated in Fig. 1 and instructed to tell the experimenter, before making a choice, whether the large or the small one was correct. He soon learned to precede his choices with the appropriate label which, in this instance, would be "large." Since in the second discrimination "small" was the correct stimulus, the label referred to the dimension that was to become relevant. If a child was trained to be an irrelevant verbalizer, he was asked in the first discrimination to tell whether the white or the black one was correct. He would thus learn to say "black," which was descriptive of the dimension that was to become irrelevant. One-third of the children at each age level were randomly assigned to be relevant verbalizers, one-third to be irrelevant verbalizers, and the remainder to a no-verbalization group who learned with no verbal labels offered or required.

All groups learned the first discrimi-

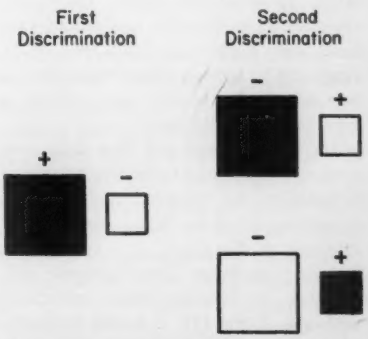

Fig. 1. Illustration of the experimental procedure showing one of the stimulus-reinforcement patterns used.

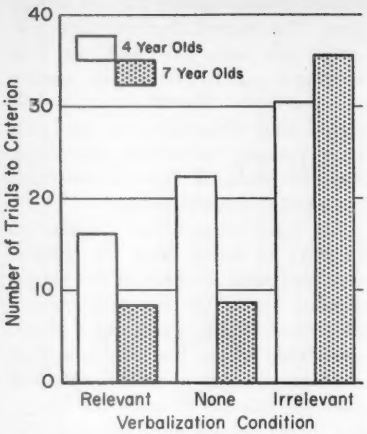

Fig. 2. Effect of verbalization on the acquisition of a reversal shift for 4- and 7-year-old children.

nation to a criterion of nine out of ten successive correct responses, after which the second discrimination was immediately presented without any further instruction or ostensible break in the procedure.

Previous research has found that when no verbalization is required, young children perform a reversal shift more slowly than older children (*2*). This finding is confirmed by the difference between the 4- and 7-year-old, no-verbalization groups of the present study ($p < .05$). To account for these developmental differences it has been suggested that older children are more likely than younger children to make covert mediating responses that facilitate such shifts (*1*, *2*).

One likely mediating mechanism is language. The results shown in Fig. 2 lend considerable support to this hypothesis. For both ages combined, relevant labels facilitated and irrelevant labels retarded the shift. These differences, as assessed by analysis of variance, were highly significant ($p < .005$). Apparently, spoken labels that refer to conceptual dimensions *can* mediate a reversal shift in children.

Having demonstrated that their own spoken words are an effective source of stimulation for children and that the experimental procedure employed is sensitive to this effect, it is appropriate to raise questions about possible differences in responsiveness associated with age. Luria (*3*), a Soviet psychologist, has proposed that in the early stages of child development speech is merely a means of communication; not until about 5 years of age does it become a regulator of actions. According to his thesis the effects of verbalization in our experiment should be different for the two age levels. While the results in Fig. 2 suggest that they are different, the implied statistical interaction falls short of significance ($.05 < p < .10$). Consequently, definitive conclusions must await further research. There are, however, some interesting relationships suggested, if not confirmed by these data. For the 7-year-olds, relevant verbalization was no better than no verbalization. This result is consistent with the hypothesis that at this age level children are likely spontaneously to supply relevant mediators and, therefore, need no help from the outside. For the 4-year-olds, relevant verbalization did show a positive influence. This influence was so small, however, that it only decreased slightly rather than eliminated the difference between the ages.

Irrelevant verbalization interfered with the performance of both age groups. The effect for the younger children was again in the right direction but rather weak. For the older children the interference due to irrelevant verbalization was potent, as would be expected if they were particularly sensitive to their own words.

In general, the analysis by age indicates that, at both age levels, the behavior of the children was regulated by their verbalizations. Although no statistically significant evidence indicated that the extent of the regulation was different for the two age groups, this possibility must still be considered (*4*).

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2 August 1961

Electron Diffraction from Coals

Abstract. Electron diffraction patterns have been obtained for coals of different rank by transmission through ultrathin sections 500 to 2000 angstroms thick. Analysis of these patterns for the distribution of atoms in coals by Debye radial distribution functions should furnish information complementary to that derived from x-ray studies, considering the differences in wavelength of the radiation involved and the different mechanisms governing the diffraction.

Because fast electrons have much shorter wavelengths than x-rays and their diffraction is proportional to the potential within the crystal (or molecule) rather than to the electron density of the atoms, electron diffraction is a powerful tool in solid-state studies. Heretofore, attempts to obtain electron diffraction patterns of coal have not been successful. Mackowsky and Nemetschek (*1*) reported that finely divided coal preparations graphitized upon exposure to an electron beam. Westrik (*2*) reported a diffraction pattern from a bituminous coal showing a distinct hexagonal crystallinity; the *a* spacing of the hexagonal lattice was 5.2 A compared with 2.46 A of graphite. The pattern was most likely produced by impurities either already present in the coal or introduced during preparation (*3*).

Electron diffraction patterns can be obtained by reflection from the surface of solid specimens. The reflection pattern of an anthracite is shown in Fig. 1*a*. The pattern reveals clearly the usual (002), (10), and (11) (*4*) reflections of aromatic molecules as shown in the densitometer tracing (Fig. 1*b*). Electrons do not penetrate more than several hundred angstroms, and the surface of the specimen is not uniform on the scale of depth of penetration; therefore, the electrons pass through excrescences on the surface. The process has much more the character of transmission than reflection. However, in this method the geometry of the scattering portion of the sample is undefined, and the distance from specimen to plate is uncertain because the diffraction patterns obtained are limited to scattering angles of a few degrees. In addition to these uncertainties, obtaining diffraction patterns from coal surfaces is extremely difficult —that is, it is a hit-or-miss process.

Well-defined electron diffraction patterns can be obtained by using uniform sections sufficiently thin to permit trans-

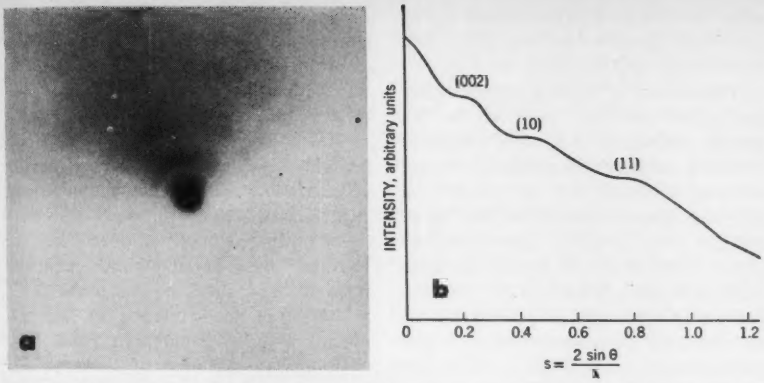

Fig. 1. (*a*) Reflection electron diffraction pattern of an anthracite. (*b*) Densitometer tracing of the same pattern.

mission of electrons. The difficulty in obtaining such sections is probably the reason coals have not heretofore been studied by electron diffraction. With the development of techniques of obtaining ultrathin sections of coals of various ranks (*5*), it is now possible to make such studies. These sections vary in thickness from 500 to 2000 A. Difficulties previously encountered with granular samples are avoided with ultrathin sections. Impurities are not introduced as in grinding, and the ultrathin sections do not absorb enough energy to cause changes. Preliminary qualitative results are reported here. In Fig. 2 are shown the diffraction patterns of vitrinite components of a high volatile A bituminous coal, an anthracite, and a meta-anthracite. The pattern of the high volatile A bituminous coal reveals only the (002), (10), and (11) reflections clearly. The pattern of the anthracite reveals the (002), (10), (004), (11), (006), (20), (21), (30), and (22) reflections of stacked aromatic molecules (indexing was done by examining the negative). The rings belonging to the (002) and (004) reflections, the first and third (very diffuse) rings from the central spot, are uneven in darkening, that is, more or less crescent shaped, indicating an anisotropic structure and preferential orientation in the sample. This is in accordance with observations made of x-ray reflections from slab specimens cut from an anthracite block. The meta-anthracite pattern shows sharp rings corresponding to the three-dimensional reflections of graphite. The following reflections are present: (002), (100), (101), (004), (103), (110), (112), (201), (114), (121), (300), and (220). These peaks are the same as those seen in an x-ray diffraction pattern of this meta-anthracite.

Because the relation between the radial distribution functions of the potential and those of the total charge (atom) distribution is established (*6*), electron diffraction provides two bases for the Fourier synthesis. For noncrystalline materials the synthesis desired most is that for the distribution of the atoms. Representing the distribution of atoms about any one atom by a density function $\rho(r)$ such that $4\pi r^2\rho(r)\,dr$ is the number of atoms between r and $r + dr$ from the atom under consideration, the intensity $i(s)$ in atomic units can be expressed as

$$si(s) = 2\int_0^\infty r\rho(r)\sin(2\pi sr)\,dr \quad (1)$$

where s is defined from $s = (2\sin\theta)/\lambda$, θ being one-half of the scattering angle and λ the wavelength. Applying the Fourier inversion

$$r\rho(r) = 2\int_0^\infty si(s)\sin(2\pi sr)\,ds \quad (2)$$

The experimentally determined values of $i(s)$ are due to the deviation of ρ from ρ_0, the average density of the sample; therefore Eq. 2 should be modified as

$$4\pi r^2[\rho(r) - \rho_0] = 8\pi r\int_0^\infty si(s)\sin(2\pi sr)\,ds \quad (3)$$

Equation 3 can be evaluated numerically by the use of a computer provided $i(s)$ can be obtained from the experimentally observed scattering intensities and provided these intensities extend to a large value of s beyond which $i(s)$ essentially is zero. The latter requirement is the result of the integral calling for $i(s)$ values extending to $s = \infty$. In the case of x-rays $i(s)$ can be calculated directly from the observed intensities, but the range of s is limited; $s_{max} = 1.28$ A^{-1} for CuKα radiation and 2.79 A^{-1} for MoKα radiation. For electrons, however, $i(s)$ is generally determined indirectly and thus is subject to uncertainties, but owing to the shorter wavelength of electrons, scattered intensities extend to much larger values of s, 4 A^{-1} or larger. Because of the uncertainties, quantitative interpretations of the electron diffraction patterns are being approached cautiously. Preliminary to meaningful diffraction analyses, $i(s)$ values obtained from electron and x-ray patterns will be compared in the region of s where they overlap. If these results can be reconciled satisfactorily, it is believed that information gained from the extended range of electron diffraction will be an important complement to that derived from x-ray studies.

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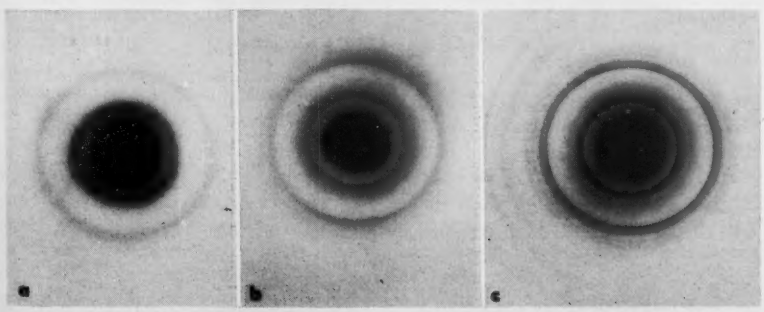

Fig. 2. Electron diffraction pattern from ultrathin sections of (*a*) a high volatile A bituminous coal, (*b*) an anthracite, (*c*) a meta-anthracite.

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24 May 1961

Accumulation of Potassium Anaerobically by Renal Medullary Slices

Abstract. Potassium accumulation occurred in leached slices of the inner medulla of the dog kidney incubated under anaerobic conditions at 37°C with glucose as substrate, but was blocked by inhibitors of glycolysis. Aerobically, only slight accumulation occurred with succinate as substrate at 37°C, and this was blocked by dinitrophenol. These findings were in contrast to those obtained with kidney cortex slices under the same conditions.

Recent work from this laboratory (*1*) showed that tissue slices of the inner zone of the medulla of the dog kidney have a high rate of anaerobic glycolysis and a low rate of oxygen consumption when compared to slices of the cortex of the kidney. It was further found that increasing the osmolality of the medium by addition of sodium chloride caused no diminution in the rate of glycolysis of the medullary slices until the osmolality exceeded 1100 to 1300 mosm/kg of water; the cortical slices, on the other hand, were inhibited progressively as osmolality was increased above the control level of 300 mosm/kg of water. Respiration was similarly inhibited in both types of slices by increasing osmolality.

These findings, considered with other evidence derived from physiological investigations, suggest that the renal medulla *in situ* derives its energy in a milieu of high osmolality mainly from anaerobic pathways. In view of the role of the loops of Henle and the collecting ducts in the countercurrent mechanism for urinary concentration, we have conducted studies concerned with the identification and characterization of active transport systems for ions in this tissue. In the course of these studies, a novel type of potassium accumulation has been found, an accumulation that appears to be dependent upon anaerobic rather than aerobic metabolism. This report is based on studies of this system and compares it to the system for potassium accumulation in the kidney cortex previously described by Mudge (*2*) and by Whittam and Davies (*3*).

Tissue slices of the dog kidney cortex and inner medulla, prepared as described elsewhere (*1*), were incubated in Krebs-Henseleit bicarbonate medium without substrate for 30 minutes at 0°C and gassed with either N_2-CO_2 or O_2-CO_2 (see Table 1). These leached slices were then transferred to fresh Krebs-Henseleit bicarbonate medium containing substrate and reincubated for an additional 45-minute period under conditions shown in Table 1. Then the slices were removed, blotted, weighed, and dried. Potassium was measured on nitric acid digests of the tissue and on the medium by internal standard flame photometry.

Table 1 shows that leached slices of the inner medulla reaccumulate potassium when incubated under anaerobic conditions (at 37°C) with glucose as substrate. This reaccumulation of potassium, although it never reached in vivo levels, was blocked by iodoacetate, fluoride, or ouabain, or by carrying out the incubation at 0°C. Pitressin had no effect. Increasing the osmolality to 1.02 or to 2.10 osm/kg of water by addition of sodium chloride blocked reaccumulation. This effect is probably not mediated specifically through failure of energy metabolism, since previous studies (*1*) have shown that osmolalities in the range of 1.0 osm/kg of water do not inhibit anaerobic glycolysis in medullary slices.

When leached slices of the inner medulla were incubated aerobically with succinate as substrate they showed only slight accumulation of potassium compared with that observed anaerobically. Further losses of potassium occurred from leached slices incubated at 0°C, at 37°C, in the presence of dinitrophenol, or greatly increased osmolality.

Comparative studies of slices of the kidney cortex showed a different pattern of behavior from that observed in the inner medullary slices. Anaerobic incubation of leached cortical slices caused a loss of potassium; iodoacetate, fluoride, and high osmolality all increased the loss, while ouabain and Pitressin had no effect beyond that observed for the control. When the incubation was carried out anaerobically at 0°C, the loss was less than that observed at 37°C.

Aerobically the results confirm those previously reported by others (*2,3*). Reaccumulation of potassium occurred in the complete medium at 37°C but not at 0°C. Losses of potassium occurred from leached slices in the presence of dinitrophenol or increased osmolality.

Table 1. Influence of various factors upon potassium reaccumulation in leached slices of inner medulla and cortex of the dog kidney. The slices were leached in Krebs-Henseleit bicarbonate medium without substrate at 0°C for 30 min. Further incubations were then carried out in a complete medium composed of Krebs-Henseleit bicarbonate medium with 10m*M* glucose (anaerobic incubations) or 10m*M* succinate (aerobic incubations). The potassium concentration of the complete medium was 6 to 7 meq /lit. Gas phases were 5 percent CO_2 in either 95 percent O_2 or N_2 at 37°C and 2.8 percent CO_2 in either 97.2 percent O_2 or N_2 at 0°C. Inhibitor concentrations were: iodoacetate, $1.7 \times 10^{-3}M$; sodium fluoride, $5 \times 10^{-2}M$; ouabain, $10^{-6}M$; Pitressin (Parke Davis), 0.2 unit /ml; dinitrophenol, $2 \times 10^{-4}M$; osmolality of the medium was increased by addition of sodium chloride. The concentration gradient for potassium was computed as follows: (μmole K^+/g of tissue water) ÷ (μmole K^+/ml of medium). No appreciable change in the pattern of the data results if the contribution of the extracellular space is neglected in this calculation. The gradient for fresh tissue was calculated by using the determined values for serum potassium. Data shown represent mean and standard deviation; the numbers in parentheses represent the number of experiments.

Conditions	Concentration gradient for K^+	
	Inner medulla	Cortex
Fresh tissue	9.91 ± 0.35 (21)	17.50 ± 0.40 (15)
After leaching at 0°C, gassed with N_2–CO_2	2.21 ± 0.10 (11)	6.15 ± 0.59 (11)
Further anaerobic incubations:		
At 37°C	3.66 ± 0.13 (9)	2.67 ± 0.05 (12)
At 0°C	1.73 ± 0.13 (6)	5.57 ± 0.37 (4)
With iodoacetate	1.42 ± 0.03 (3)	1.71 ± 0.04 (3)
With fluoride	2.25 ± 0.02 (3)	1.88 ± 0.05 (3)
With ouabain	1.91 ± 0.04 (3)	2.83 ± 0.07 (2)
With Pitressin	3.86 ± 0.10 (3)	2.70 ± 0.09 (3)
At 1.02 osmolal	1.38 ± 0.07 (3)	2.23 ± 0.14 (2)
At 2.10 osmolal	1.38 ± 0.06 (3)	1.43 ± 0.06 (3)
After leaching at 0°C, gassed with O_2–CO_2	2.22 ± 0.03 (2)	6.25 ± 0.55 (2)
Further aerobic incubations:		
At 37°C	2.63 ± 0.10 (2)	14.10 ± 0.70 (2)
At 0°C	1.98 ± 0.17 (2)	4.00 ± 0.14 (2)
With dinitrophenol	1.65 ± 0.14 (2)	2.93 ± 0.12 (2)
At 1.04 osmolal	2.28 ± 0.07 (2)	2.19 ± 0.18 (2)
At 1.68 osmolal	1.20 ± 0.01 (2)	1.49 ± 0.02 (2)

The results of these experiments demonstrate that inner medullary slices can accumulate potassium against concentration gradients and that this accumulation is dependent upon anaerobic rather than aerobic energy metabolism.

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22 June 1961

Effects of Context on the Subjective Equation of Auditory and Visual Intensities

Abstract. Thirty-six subjects were instructed to equate the loudness of a pure tone with the brightness of an illuminated field. Eighteen of the subjects had been given brief preliminary experience with tones of low intensity; the remaining 18, with tones of high intensity. A significant and substantial effect upon equation was demonstrated.

Several recent studies have suggested that "sensory magnitude" is a self-evident dimension, susceptible of direct introspective evaluation even by inexperienced subjects (*1*). Such subjects are capable of consistent judgments of "sensory magnitude"; furthermore, they seem to be able to match the intensity of a sensation in one modality with that of a sensation in another in a manner consistent with their first-order judgments.

Without disputing the basic data, Warren (*2*) has vigorously questioned the presumption that they represent a sensory dimension, rather than an essentially perceptual continuum. Garner (*3*), also, has emphasized that judgments of this sort can be "reliable" without being "valid" and has demonstrated that the context in which direct judgments of sensory intensity are made can have a radical influence upon their magnitudes. We have investigated, analogously, the effects of context upon the cross-modality equation of "sensory intensities."

Thirty-six female undergraduates were divided at random into two groups ("low" and "high") of 18 members each, and each subject was tested individually in a soundproof, lightproof room. A subject of either group was seated alone in the experimental room, the experimenter maintaining contact with her by means of a Teletalk communication system. After a dark-adaption period of 3 minutes, the subject began a series of visual judgments. At a distance of 18 inches from her eyes, she was presented with an illuminated disk, 1.5 inches in diameter (visual angle, 4°48′), produced by passing the beam from a 200-watt slide projector through an Eastman No. 58 Wratten ("green") filter and then through a small port in the exterior wall of the experimental room; the beam was finally used to illuminate from the rear a translucent plastic screen, set in the interior wall of the room and masked down to form the circular patch described. The intensity of the projector's beam was controlled by use of a General Radio Variac, monitored by electronic voltmeter; filtering of the beam served to prevent perceptible changes of hue in the stimulus. On each trial, the subject was first presented with a stimulus of 15 db (reference level, 0.15 mlam) for 2 seconds, and then immediately with one of either 0, 5, 10, 15, 20, 25, or 30 db for a further 2 seconds; all the timing of stimuli was accomplished automatically by a Hunter timer. The subject was asked to estimate the sensory intensity of the second stimulus on a scale which took that of the first arbitrarily as 10. Each comparison-stimulus was presented five times, in a random order unique to each subject; thus, she was required to make 35 visual judgments.

In a similar fashion, the subject next undertook 35 auditory estimations. Tones of 1024 cycles whose purity had been verified by oscilloscope were administered monaurally, with a Western Electric 6B audiometer as a source. A subject in the low group judged stimuli of either 25, 30, 35, 40, 45, 50, or 55 db (reference level, normal threshold) with respect to a standard of 40 db; a subject in the high group judged stimuli of 55, 60, 65, 70, 75, 80, or 85 db against a standard of 70 db. Again, there were five estimates at each possible level, randomly ordered; again, each standard was arbitrarily labeled 10.

As a final task, the subject performed 15 cross-modality equations. A visual stimulus at the level of 0, 15, or 30 db was presented for 2 seconds, along with a tone of 55 db. At the subject's direction, this tone was altered in 5-db steps in additional simultaneous administrations until she was satisfied that a match in sensory intensities had been achieved. To obviate the possibility of mere "semantic matches" in this phase of the experiment, instructions emphasized that the numbers previously assigned to the stimuli were now of no significance and that they were to be ignored in making the cross-modality matches. Visual levels were ordered at random; there were five equations of sound with light at each of the three levels of brightness.

After each subject had made five judgments or five equations at each level of stimulation, the five values were averaged to provide a single score for the subject at that level. Figure 1

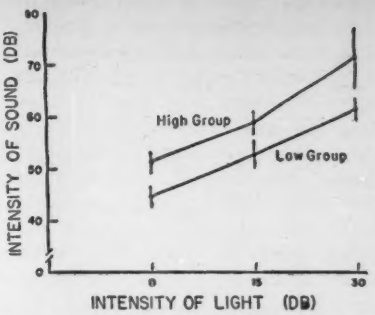

Fig. 1. Mean sound intensities required for equation with each of three light intensities, for each group of subjects ($N = 18$ per group). Vertical bars indicate $\pm \sigma$.

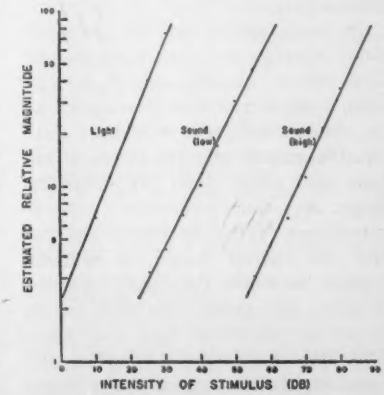

Fig. 2. Mean estimates of relative sensory magnitudes for light (function at left; $N = 36$, standard = 15 db), for sound at low level (middle function; $N = 18$, standard = 40 db), and for sound at high level (function at right; $N = 18$, standard = 70 db).

shows the means of these scores for each group, at each level of illumination, in the task of equating sound with light; vertical bars indicate $\pm 1\,\sigma$ at each point. To reach subjective equations with the same levels of illumination, the high group required systematically greater intensities of sound than the low group. When a single composite score (mean of the subject's three deviations from the respective over-all means at the three levels of illumination) is assigned to each subject, the mean of such scores is +3.74 db ($\sigma = 2.82$) for the high group and (necessarily) −3.74 db ($\sigma = 2.57$) for the low group; $t = 8.31$, and $p < .0_5 1$.

Subsidiary results may be of some interest. Figure 2 summarizes the first-order estimations of relative magnitude for light (N=36), for sound at the lower level ($N = 18$), and for sound at the higher level ($N = 18$). The graphical points indicate mean scores (*4*), and the straight lines have been fitted by the method of orthogonal polynomials (*5*). The slope of the light line is .50; and the slopes of the low-level and high-level sound lines are, respectively, .40 and .43, considered in terms of acoustic energy. Results for individual subjects are not shown. Among all 36, however, mean slope of individual light function was .49; the range of individual slopes was from .24 to .78 ($\sigma = .11$). Among the 18 subjects in the low group, mean slope of sound function was .39 (range, .18 to .56; $\sigma = .11$), and among the 18 subjects in the high group, mean slope of sound function was .42 (range, .23 to .60; $\sigma = .10$). Again, all slopes were computed by the method of orthogonal polynomials.

It would appear that the cross-modality equation of "sensory magnitude" is a process strongly subject to contextual effects and thus presumably not an absolute judgment of sensory quality. We suspect that the slopes of our light and sound lines are somewhat larger than usually reported (*1*, *6*; although see *7*), too, because of the context (a narrow range of stimulus values) in which they were obtained. Finally, the great variability among slopes of individual light and sound functions is worthy of note; such variability is not suggestive of a simple sensory process (*8*).

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2 August 1961

Coesite Discoveries Establish Cryptovolcanics as Fossil Meterorite Craters

Abstract. Discovery of coesite in St. Peter sandstone from the central uplift of the Kentland structure, Newton County, Indiana, and in shatter cones of Lilley dolomite of Middle Silurian age from the central uplift of the Serpent Mound structure near Sinking Springs, Ohio, proves that shatter cones are evidence of meteorite impact.

The association of the high-pressure silica polymorph, coesite, with meteorite craters is now widely accepted, a little more than a year after this important discovery by E. C. T. Chao and associates (*1*). Coesite has been found by these workers at Canyon Diablo (Barringer) Crater, Arizona, the Rieskessel of Miocene age in Germany, Wabar Crater in Saudi Arabia, Bosumtwi (Ashanti) Crater in Ghana, and at the artificial Teapot Ess Crater at the Nevada Proving Ground. This work has recently been summarized by Dietz (*2*).

Shatter cones, first discovered at the Steinheim Basin early in this century, have been associated with many cryptovolcanic structures by Dietz (*3*). Shatter cones are associated with six of these structures in the United States. Chao discovered a small fragment of shattered sandstone in the fallout at Canyon Diablo Crater (*2*).

Coesite was concentrated from a Serpent Mound shatter cone that weighed over 2 lb by dissolving the carbonate in hydrochloric acid. The residue was treated by methods described by Chao and co-workers (*4*). Sufficient material was recovered for petrographic identification and photomicrography. Small individual grains in the acid residue have a mean refractive index of 1.591 and show the strain characteristic of natural coesite. In the specimens collected the coesite content appears to be only 10 parts per million. An x-ray rotation photograph was taken of a hand-picked grain which gave the reflections for the 3.1-A d spacing, the strongest reflection of coesite. The x-ray diffraction spots were of low intensity; therefore it was assumed that coesite is present as small inclusions in the large grain. The refractive index of the grain is 1.560, and the grain is amorphous, as the only pattern on the x-ray film other than that of coesite is a diffuse halo. Core drilling of this uplift might yield material of higher coesite content.

The low coesite content in the Serpent Mound material prompted a field trip to the McCray quarry in the Kentland structure, 3 miles east of Kentland, Indiana. Coesite was detected optically in St. Peter sandstone and in breccia. The finest fraction (−320 mesh) from St. Peter sandstone (about 98 percent silica) was found to contain most of the coesite. The residue after hydrofluoric acid treatment consisted predominantly of zircon with smaller amounts of tourmaline and coesite. Table 1 shows the seven d spacings of coesite with which zircon and tourmaline did not interfere. In addition there are four coesite lines coincident with zircon and two with tourmaline. Comparison with Boyd and Eng-

Table 1. Comparison of x-ray diffraction powder data (d spacing and intensity) between Kentland coesite (as found in this study) and synthetic coesite (as found by Boyd and England, *5*).

Synthetic coesite		Kentland coesite	
d(A)	Intensity	d(A)	Intensity*
6.19	3		
4.37	2		
3.436	52	3.438	M
3.099	100	3.089	VS
2.765	8	2.77	W
2.698	11		
2.337	3		
2.295	6	2.29	W
2.186	4	2.18	W
2.033	6		
1.849	5	1.84	VW
1.839	3		
1.794	4	1.79	W
1.787	4		
1.715	9		
1.698	10		
1.655	6		
1.584	5		
1.548	6		
1.409	2		
1.345	6		

* Intensity: M, moderate; VS, very strong; W, weak; VW, very weak.

land's data (*5*) shows excellent agreement (see Table 1). Figure 1 is a photomicrograph of a coesite grain from the St. Peter sandstone. The highest concentration of coesite found in Kentland material is 100 parts per million, in the St. Peter sandstone of Middle Ordovician age.

The two coesite discoveries reported here are from material in which the concentration is from 2 to 3 orders of magnitude more dilute than reported earlier in meteorite crater glasses (*1*, *4*). They may also represent the oldest sources of natural coesite now known. The Serpent Mound structure is post-Lower Mississippian and pre-Illinoian and the Kentland structure is post-Middle Ordovician and pre-Pleistocene in age.

The largest shatter cone at Kentland described by Dietz is 6 feet long (*2*). However, Shrock (*6*), even in 1937, suggested that the "great curved fault surfaces in the McCray quarry have essentially the same characteristics as the small shatter cones and are believed to have been formed in the same way by the same forces." Dietz discovered small shatter cones as float on the central uplift of Serpent Mound in 1959 (*3*).

We believe that the central uplift remaining at Kentland is an imbrication of megashatter cones. The photograph on the cover of this issue of *Science* shows the mold of the top of one of the smaller megashatter cones. This is one unit of several conical structures that comprise a large megashatter cone which is a large portion of the extreme southeast face of McCray quarry. The exposed over-all dimensions of this large megashatter cone are 250 feet wide at the quarry floor and 160 feet high. The root extends downward below the quarry floor for an unknown distance.

From a reconnaisance field observation, several characteristics pertaining to vertical uplift (1500 feet, according to Shrock, *6*) and intense rock failure are apparent. Numerous drag folds occur along high angle normal faults which appear to radiate outward from the center of impact. The Platteville carbonates, which in normal stratigraphic sequence overlie the Glenwood and St. Peter sandstones, have developed fracture cleavage and envelop the observable megashatter cones, the apexes of which all point upward. The bedding of these carbonates parallels the surfaces of the megashatter cones. This indicates that those beds that now

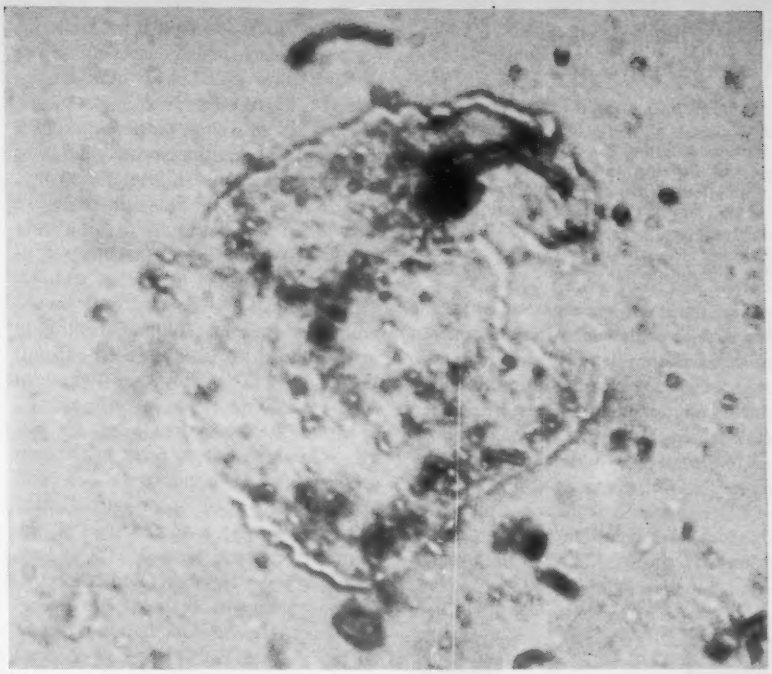

Fig. 1. A photomicrograph (taken slightly out of focus) of coesite from St. Peter sandstone, Kentland, Indiana, in 1.591 immersion oil. The grain diameter is 79 μ.

constitute the megashatter cones have been displaced upward, causing deformation of the originally overlying strata. Complex fractures were also observed in the sandstone of the megashatter cones. Thus the entire uplift may have been one large megamegacone containing a small central crater produced by the explosive jet of the meteorite when it reached its maximum penetration. This uplifted structure in the center of a large crater thus would have many megacones which were thrust upward and outward together from this center, the voids between cones being filled with folded and compressed overlying strata. The interstices then remaining in the entire mass were instantly injected with compressed breccia. No shatter cones were observed in any of the breccia at the quarry, which indicates that the breccia was injected after the explosive impact. Without the present large quarrying operation this magnificent and geologically awe-inspiring structure would be hidden.

The McKee quarry, situated about 1100 feet to the east of McCray quarry, has many small shatter cones ranging in size from a few inches to several feet long, mostly pointing horizontally away from the center of the disturbance. The shatter cones are in Platteville carbonates which elsewhere overlie the St. Peter sandstone. This outcrop may have been displaced as a unit from near the center of the explosion.

Further study and core drilling of these features offers the most economical way of attaining some understanding of the root structures and central uplifts of terrestrial and lunar craters. These six known structures in the United States are indeed invaluable but as-yet unexploited national scientific assets to those interested in the cosmosciences (*7*).

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28 September 1961

Electroretinogram of the Visually Deprived Cat

Abstract. Cats kept in darkness from birth show a subnormal *b*-wave in the electroretinogram to 4 weeks of age but quickly develop the full response upon stimulation. When the cats are kept without light for 1 year, the response recovers slowly after intense stimulation. A 2-day exposure to light is sufficient to reverse this diminution in response.

Zetterström (*1*) reported that the appearance of the electroretinogram can be delayed considerably by rearing animals in darkness. She found that the electroretinogram was suppressed in dark-reared kittens or, if present, was of longer latency than that of light-reared controls during the first 4 weeks of life. A striking finding was that differences between the electroretinograms of light-reared and of dark-reared animals vanished if the dark-reared animals were subjected to one testing session, which consisted of about 30 flashes of light distributed over a period of 3 hours. It was not possible to delay the appearance of the electroretinogram beyond 4 weeks of age by dark rearing; kittens kept in darkness until they were more than 4 weeks old before being exposed to light showed an electroretinogram comparable to that of controls of the same age. Zetterström's measurements were all confined to the *b*-wave; the *a*-wave is not recorded until a later age. The effects of long-term dark rearing were not investigated.

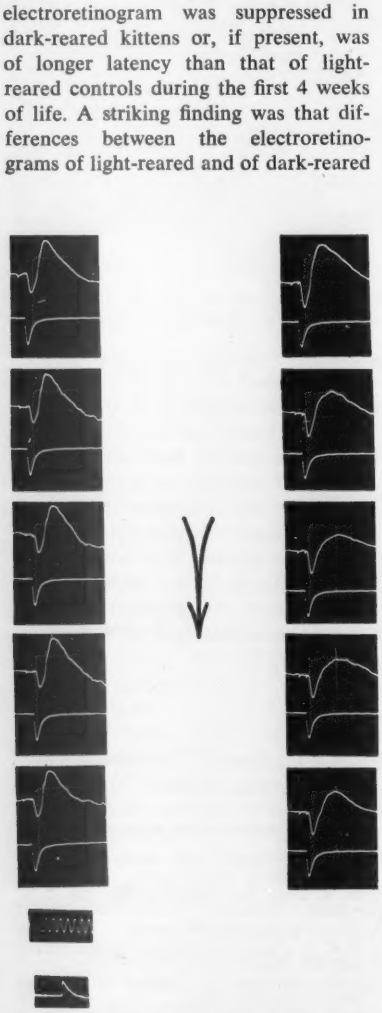

Fig. 1. (Left) An electroretinogram from a control animal: (from top) five recordings taken at 10-second intervals. (Right) Recordings obtained, under the same conditions, from an animal reared in darkness for 1 year. The change in amplitude of the *b*-wave (upward deflection) during the series is evident. Time calibration, 50 cy/sec; amplitude calibration, 200 μv. The break in the bottom line of each record indicates onset of the light flash.

In the study reported here, ten kittens were raised from birth in the laboratory, five in continuous darkness and five controls in the normally lighted animal room. At 1 year of age all the animals were anesthetized with sodium pentobarbital (Nembutal) and electroretinograms were obtained with a corneal electrode. Stimuli at five different intensities (see Fig. 1) were produced with a Grass PS-1 photic stimulator. All the animals were first light-adapted and then dark-adapted for 1 minute before testing began.

It was found that there were no significant differences between the electroretinograms of the two groups of animals when 1 minute elapsed between stimuli. When, however, a series of five flashes at the higher intensities was presented at the rate of one every 10 seconds, there was a diminution in the amplitude of the *b*-wave following the earlier flashes (Fig. 1). The effect was not observed with flashes at the two lowest intensities.

The differences between the groups at the three highest intensities were shown by rank analysis of variance to be significant at better than the .01 level. Averaged results for the two groups are shown in Fig. 2. No significant differences in either latency or amplitude were found for the *a*-waves of light-reared and dark-reared animals. When the dark-reared animals were placed in the lighted animal room it was found that exposure to 48 hours of illumination was sufficient to eliminate the diminution of the *b*-wave response to a train of high-intensity stimuli.

It is interesting to note that the change in amplitude of the *b*-wave during a train of stimuli found in the dark-reared animal is similar to the change found by Horsten and Winkelman (*2*) to be produced in the cat during impaired oxygen supply and referred to by them as the "exhaustion phenomenon." Thus, it is suggested that exclusion of adequate stimulus to the cat retina during post-partum maturation produces some sort of deficiency in retinal metabolism, but one which is reversed upon surprisingly short exposure to light.

Glucose and oxygen were once thought to be the primary, if not the exclusive, requirements for the functional metabolism of retinal and central neurons. More recently, ribonucleic acid and protein have been found to participate in such metabolism (*3*). Hellström and Zetterström suggest specifically that a primary correlation may exist between the level of the sulfhydryl groups in the retina and the appearance of the electroretinogram. Levels of ribonucleic acid in the nuclei and cytoplasm of ganglion cells are quickly altered by variations in the functional demands imposed by stimulation. Chronic depression of protein and ribonucleic acid follows prolonged visual deprivation, but the study under discussion and others carried on in our laboratory (*4*) lead to the conclusion that, until such depression is extreme, normal physiological functions of neu-

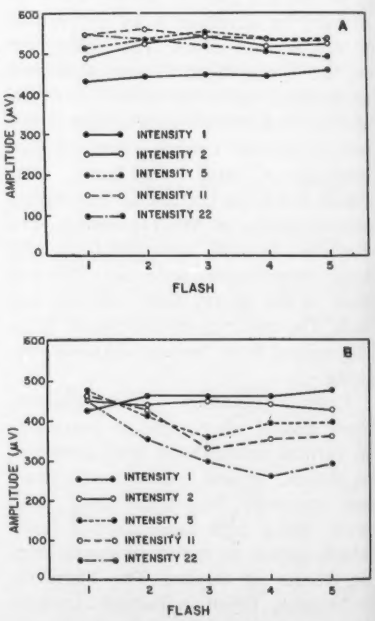

Fig. 2. (*A*) Averaged data for control group: amplitude of *b*-wave as a function of the order of flash in a series. (*B*) Averaged data for dark-reared group: the change in amplitude of the *b*-wave during a series at high intensities of stimulation is clear. Intensity of stimulus light is given in lumen-seconds per square foot (data from manufacturer).

ral transmission may not be impaired. The more intimate relations between neurons may, however, be affected in such a way that only tests of complex perceptual processes will reveal the visual deficits produced by visual deprivation (*5*).

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3 July 1961

Predictions of the Growth Model for Normal Chicken Growth

Abstract. The model of growth control advanced by Weiss and Kavanau has been further evaluated with an I.B.M. 7090 computer. Predictions for the concentration of growth-inhibiting substances and their quantitative distribution in the animal are in good agreement with known developmental changes. Results are being used to predict the course of compensatory organ growth in the immature animal.

The theory of growth control advanced by Weiss (*1*) has been formulated into a set of three simultaneous differential equations by Weiss and Kavanau (*2*). The mathematical model extends beyond a mere representation of normal growth to growth disturbances and regulation and dissects the growth problem into a series of detailed questions which lend themselves to experiment. Some of these questions concern changes in volume of body fluids and concentration of postulated growth-inhibiting substances. Predictions for these changes based upon data for normal chicken growth follow.

The basic assumptions upon which the model was predicated are:

1) The gain in mass of a living system is the net balance of mass "produced" and retained over mass "destroyed" and otherwise lost.

2) The mass M of the system consists of two functionally different components: The generative mass G, comprising the instruments of protoplasmic reproduction, and the differentiated mass D, derived from G and consisting of terminal products and other derivatives that do not reproduce.

3) Each specific cell type reproduces its protoplasm through the self-duplication and catalytic activity of "templates" characteristic of that cell type. Each cell also produces specific, freely diffusible "antitemplates" which can inhibit the activity of the corresponding templates, and which become distributed in the "dilution pool" V (which includes the blood, lymph, intercellular fluids, and other parts of the body to which they gain access).

4) The antitemplates regulate growth by a negative feedback mechanism, in which their increasing populations render an increasing proportion of the homologous templates ineffective, resulting in a corresponding decline in growth rate.

5) Attainment of terminal size represents a stationary equilibrium between incremental and decremental growth components.

6) The generative mass, and the differentiated mass including the antitemplates, undergo continual metabolic degradation and replacement.

Recently, predictions of the model were determined for compensatory organ growth in the adult (*3*). By reason of the model's explicitness, several possible mechanisms considered in the more general scheme of growth control (*2*) were ruled out as unrealistic. For example, of the various alternative sources of production of the antitemplates, all were ruled out except the generative mass.

The model reproduces a number of phenomena observed in the compensatory response to disturbance of equilibrium of organ systems. Thus it reproduces the spurt of compensatory growth of an organ system after artificial reduction and the spontaneous resumption of organ growth after artificial lowering of antitemplate concentration at terminal equilibrium [observed in liver plasmapheresis experiments with adult rats (*4*)]. It predicts that compensatory organ growth will proceed in an undulatory fashion and accounts for the heretofore unexplained secondary spurt of growth (after the first week or so) in partially hepatectomized rats. It accounts for the fact that liver cell-protein synthesis in the regenerating rat liver attains its maximum rate before plasma-protein synthesis does (*5*), and it predicts the decrease in rate of regeneration of organ mass with increasing age. Additionally, the model has directed attention to a number of questions to be decided by future experiments (*3*).

In point of fact, the model represents a class of systems controlled by negative feedback. In a formal sense it is equally valid for alternative biological systems, requiring for conversion merely simplification or reassignment of significance, or both, of variables and parameters. For this reason, and in view of the increasing weight of evidence for negative feedback control of growth processes (*1*, *6*), investigations of its predictions, stability, and general behavior after disturbances of equilibrium are significant for current studies.

Evaluation of the model for compensatory organ growth in the adult was undertaken first because the simultaneous differential equations (*2*) describing the adult system are relatively simple. Although the stability of this process in the adult has been verified for a wide range of mass reductions and other disturbances, it remains to determine predictions for compensatory organ growth in the immature animal. These are of particular interest because almost all experimentation is carried out with immature, rapidly growing animals.

In order to solve the differential equations of the model it is necessary to specify the daily rate of catabolic loss of antitemplates, k_s, and the number x of antitemplates required to inactivate each template. Since these are not known, solutions for the adult system had to be scanned with a range of biologically feasible values (*3*). These solutions, in turn, indicated probable limits for the two parameters. Accordingly, the values 10⅓, 21⅓, and 32 percent for k_s (half lives of 6½, 3¼, and 2⅙ days), and 4, 8, and 16 for x, were chosen for the present study.

To predict the course of compensatory organ growth in the immature animal, it is necessary to fit the model to the data for normal chicken growth, for each combination of values of k_s and x. Each value of x generates a curve for the antitemplate concentration C, and each value of k_s a curve for the number of antitemplates I present in the system during growth (*2*, Eqs. 4, 6a, and 21). From this information, nine curves for the growth in volume of the dilution pool V can be derived ($V = I/C$).

The findings for C, I, and V have interest beyond being prerequisite for computing compensatory organ growth in the immature animal, for they serve as additional criteria of the biological plausibility of the model and its specific solutions. The prediction of unreasonable values for them would have ruled out as inconsistent certain combinations of the parameters k_s and x.

The new results, determined with the I.B.M. 7090 of the U.C.L.A. computing facility (*7*), are shown in Fig. 1. It is evident that C must build up much more rapidly than either M or G; the higher the order of the reaction of inhibition of templates by antitemplates (that is, the larger x), the more rapid the increase must be. At hatching, values of C for $x = 4$, 8, and 16, are 63, 79, and 89 percent of the adult equilibrium value, respectively. Abrupt changes in the curves at hatching reflect the abrupt slowing of the growth rate of the chick at this time (*2*).

Of the family of nine curves for V, only three are plotted in Fig. 1. The other six lie in the narrow range between the inner and outer curves. All these curves lie close to the curve for G. For the case $x = 4$, $k_s = 32$ percent, the maximum difference between points on the curves for V and G is only 1.8 percent.

A more readily visualized entity than V is the fraction of the total volume of the animal (V_T) occupied by V, namely, V/V_T (the fraction of the chicken occupied by blood, lymph, and so forth. To derive curves for this quantity (*2*, Eq. 26), several approximations must be made. Of the nine curves obtained, three are plotted, including the limiting curves of the family. These curves indicate that a relatively large fraction of the chick embryo must be permeated by the antitemplates. Upon the basis of an assumed final value of 6 percent in the adult chicken (that is, roughly twice the blood volume), values for V/V_T in the 12-day-old chick embryo range between 7.5 and 18.5 percent; at hatching they range between 6.7 and 12.6 percent. These high early values are in good agreement with the known relative increase in solid bulk during development, as well as with the existence of an accessory fluid system in the extraembryonic area prior to hatching.

These predictions for chicken growth are biologically plausible. The ranges into which the values fall are sufficiently well delimited to permit ready experimental testing. Exploratory tests are feasible at the present time but critical tests must await the identification of the antitemplates. Promising in this connection is Glinos's tentative identification of liver growth-regulating substances with components of the plasma proteins (*4*).

Further explorations of the model are under way. These should more narrowly restrict the range of possible combinations of values of x and k_s, and, consequently, of V and C. Additionally, they will predict the course of compensatory organ growth in the immature animal. These results will provide more useful reference points for past and future experimentation than do the findings for the adult (*8*).

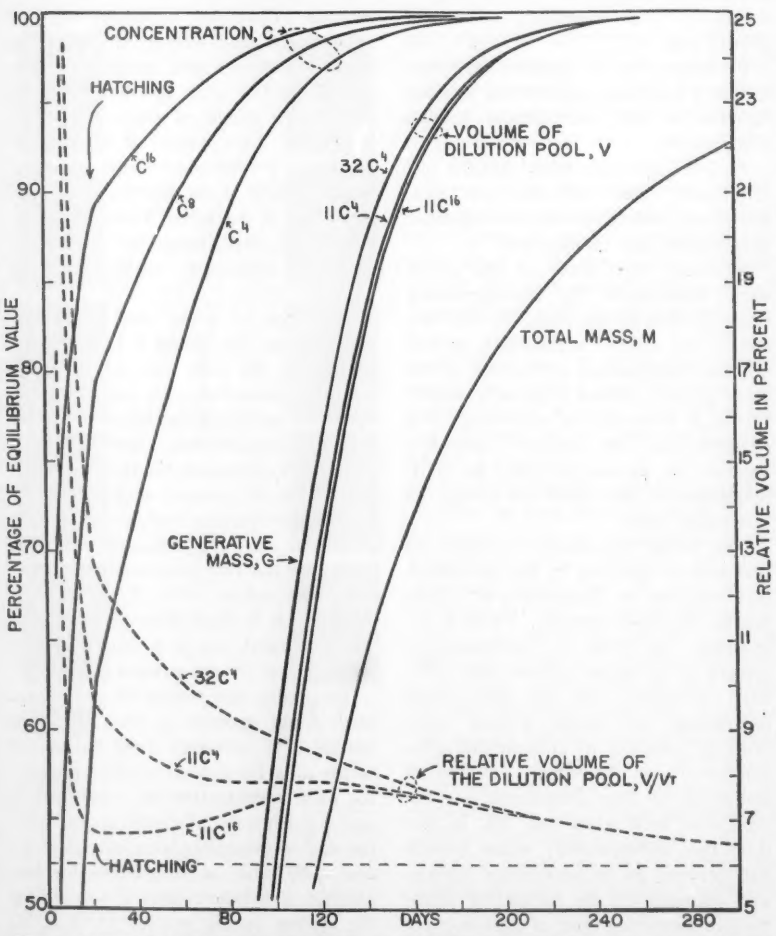

Fig. 1. Curves for the changes in C, G, M, V, and V/V_T predicted by the model for normal chicken growth. Values for k_s and x are indicated conventionally by the coefficients (rounded off to 11, 21, and 32) and exponents of C, respectively. The right ordinate scale applies only to the curves for the relative volume of the dilution pool, V/V_T. The dashed horizontal line denotes its limiting value of 6 percent.

J. Lee Kavanau

Department of Zoology, University of California, Los Angeles

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7. I am indebted to Mr. Bruce Fink for the Fortran program for these studies.
8. This work was supported by the National Science Foundation (Grant G-14533) and by Cancer Research Funds of the University of California.

14 August 1961

An Age-Dependent Change in the Response of Fern Gametophytes to Red Light

Abstract. When gametophytes of *Onoclea sensibilis* are grown in darkness a filament of a few cells develops which elongates at a constant rate. Low dosages of red light given at the beginning of growth increase the rate of elongation. After about 12 days in darkness, however, gametophytes show a decreased growth rate when given red light.

Spores of *Onoclea sensibilis* require light for germination. If sufficient light is given to insure germination and the spores are then placed in darkness, the gametophytes develop a characteristic form. No further cell divisions occur, and the gametophyte consists of a filament of one to three very elongated cells. Mohr (*1*) found that the gametophyte of *Dryopteris filix-mas*, growing on a mineral medium under continuous red light, produced a long filament of few cells, similar to but longer than plants growing in the dark. A different effect of red light was shown with gametophytes of *O. sensibilis* by Miller and Miller (*2*). Gametophytes germinated and grown for several days under white light and then transferred to darkness make only a small increase in area and cell number. Low dosages of red light (20 min per 24 hours, about 400 erg cm^{-2} sec^{-1}) permit growth and cell division in otherwise total darkness when sucrose is present in the medium; without sucrose red light is ineffective. The effect of red light is reversible by far red irradiation.

In Mohr's paper red light was shown to increase the "etiolated" character of the gametophyte, while Miller and Miller found a promotion by red light of the type of growth characteristic of light-grown gametophytes. We carried out experiments to determine whether the red-light effect reported by Mohr was found also with gametophytes of *O. sensibilis*. During the course of this work we determined that the nature of the effect of red light on filament elongation varies with the age of the gametophytes at the time red-light treatment is begun.

The method of spore sterilization and composition of the Knop's mineral medium used have been described (*2*). The light treatment for germination was given in an air-conditioned growth room at a temperature of 25° ± 2°C, with a photoperiod of 16 hours. Light was from white fluorescent tubes, about 400 ft-ca. Spores were exposed to light for 2 days on distilled H_2O, then transferred to Knop's solution with or without 1-percent sucrose and placed in an air-conditioned dark room (25° ± 2°C). Red light was given from one 15-watt red fluorescent tube at a distance of 10 cm. Growth measurements were made by projecting the images of gametophytes under a microscope onto a sheet of paper with an inclinable drawing mirror. The lengths of the gametophytes were traced on the paper and later measured with a flexible plastic rule. The actual size was calculated from the known magnification of the microscopic image.

In total darkness the filaments increase in length at approximately a constant rate for at least 3 weeks. In Knop's solution the growth rate is about 0.02 mm/day; the addition of 1-percent sucrose produces a higher rate of elongation, about 0.04 mm/day.

The effect of red light (15 min/6 hr) is dependent on the length of time the gametophytes have been growing in darkness. This is illustrated in Fig. 1, in which each point represents the average of measurements of 25 gametophytes. In this experiment gametophytes were grown on Knop's medium plus 1-percent sucrose. The solid circles represent growth in total darkness. At the times indicated by the arrows (0, 7, and 12 days in darkness) some of the gametophytes were started under the red light regime, which was continued for 4 to 5 days. The triangles show the elongation of red-light-treated gametophytes. If red light is given at the beginning of the growth period, the rate of elongation is considerably higher than that of the dark controls. After 7 days in darkness, red light has little effect on elongation, and after 12 days red light inhibits filament elongation compared with the dark-grown gametophytes. These effects of red light are independent of sucrose and take place as well on plain Knop's solution.

It is possible to study three effects of red light on gametophytes of *O. sensibilis*. If the gametophytes are treated, as in the present paper—2 days light, then darkness—one may produce an inhibition or promotion of filament elongation, depending on when the red light is given. If the gametophytes develop longer in white light, so that cell division in two planes has been initiated, red light then promotes cell division (*2*). Whether these effects are distinct or are aspects of the same process deserves further study.

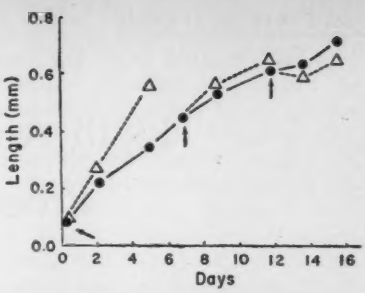

Fig. 1. Growth in length of dark-grown (circles) and red-light-treated (triangles) fern protonemata. Arrows indicate beginning of light treatment for samples at different ages.

The age-dependent promotion or inhibition of filament elongation has an interesting parallel in higher plants. Thomson (*3*, *4*) showed that red light increased the rate of elongation of very young internodes of oats and peas but inhibited the elongation of older internodes. One unresolved question pointed out by Thomson (*4*) is whether the increased rate of elongation of young internodes is a direct effect of red light or a correlative phenomenon resulting from the inhibition of the lower internodes. It is clear that the red light promotion of filament elongation is a direct effect, since the irradiation of young and old gametophytes is obligately separated in time. This feature is absent in irradiation studies of whole higher plants where many internodes of different developmental stages are present at the time of irradiation and during subsequent growth. If one is dealing with the same phenomenon in ferns and higher plants, the stimulation of young internode elongation by red light most probably represents a direct effect of light on the cells (*5*).

JOHN H. MILLER
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References and Notes

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5. The participation of one of us (D.R.W.) was made possible by a grant under the National Science Foundation's undergraduate research participation program.

2 August 1961

128th Annual Meeting: Program Summary

Zoological Sciences (F)

Wednesday 27 December

Biologists' Smoker. Joint program of AAAS Sections F–Zoological Sciences and G–Botanical Sciences, and all biological societies. Arranged by Tyler A. Woolley, Colorado State University, and Paul W. Winston, University of Colorado. Financed by donations from zoology and biology departments at Colorado State University, University of Colorado, University of Denver, Colorado College, and Colorado State College.

Friday 29 December

Zoologists' Dinner and Vice Presidential Address of Section F. Program of AAAS Section F–Zoological Sciences, cosponsored by the zoological societies meeting at Denver. Arranged by George W. Wharton, Ohio State University. C. Ladd Prosser, president, American Society of Zoologists, will preside. Human values and human genetics, Jack Schultz, Institute for Cancer Research, Philadelphia, and vice president for Section F. The business meetings of both the American Society of Zoologists and Section F will immediately follow the Zoologists' Dinner.

Section F is a cosponsor of the symposia of the American Society of Zoologists, the Society of Protozoologists, and the Society of Systematic Zoology. It is also a cosponsor of the symposium of Alpha Epsilon Delta, Career Opportunities in the Health Professions, 28 December, and of the interdisciplinary symposia on Existing Levels of Radioactivity in Man and His Environment and Geochemical Evolution, both 28 December.

American Society of Zoologists

Thursday 28 December

Concurrent sessions for contributed papers.

I: **Animal Behavior and Sociobiology, I**. Joint session of the Division of Animal Behavior and Sociobiology of the American Society of Zoologists and of the Section of Animal Behavior and Sociobiology of the Ecological Society of America, cosponsored by AAAS Section I–Psychology. George Barlow, University of Illinois, will preside.

II: **Histology, Cytology, and Genetics**. Sheila J. Counce, Yale University, will preside.

III: **Demonstrations**. Use of I.B.M. cards for custom-made bibliographic punch card systems, Hermann Meyer. Ultrastructure of nerve and satellite cells of spinal ganglia of rats treated with malononitrile, V. L. van Breemen and J. Hiraoka.

IV: **Animal Behavior and Sociobiology**, II. (Sponsorship as in Session I.) Bernard Greenberg, Roosevelt University, will preside.

V: **Invertebrate Zoology, Parasitology, and Protozoology**. Clarence J. Goodnight, Purdue University, will preside.

28–29 December

Neurosecretion, a three-session symposium. Joint program of the Divisions of Comparative Physiology and Comparative Endocrinology of the American Society of Zoologists, cosponsored by the Society of General Physiologists and AAAS Section F–Zoological Sciences. Arranged by Nancy S. Milburn, Tufts University.

Part I, Berta Scharrer, Albert Einstein College of Medicine, presiding. Neurosecretion in *Lumbricus terrestris*, Ernst Scharrer and Stanley Brown. Experimental studies of the neurosecretory activities of the thoracic ganglion of a crab, *Hemigrapsus*, Kunio Matsumoto. A thoracic neurosecretory complex in brachyura, Donald Maynard. Effects of the pericardial neurosecretory substance on the crustacean heart, Ian Cooke. The neurosecretory system of *Leucophaea maderae* and its role in neuroendocrine integration, Berta Scharrer.

Part II. Ernst Scharrer, Albert Einstein College of Medicine, presiding. Fine structure of cells within the pars intercerebralis of *Blaberus craniifer* (Blattaria), Robert B. Willey and George B. Chapman. A cytochemical study of neurosecretory and other neuroplasmic inclusions in *Periplaneta americana*, Rudolph Pipa. Neuroendocrine control of mating behavior in cockroaches, Robert Barth. Control of efferent activity in the cockroach cercal ganglion by extracts of the corpora cardiaca, Nancy S. Milburn.

Part III. Aubrey Gorbman, Barnard College, Columbia University, presiding. The caudal neurosecretory system of fishes, Howard A. Bern and Noboru Takasugi. The seasonal secretory cycle of the nucleus lateralis tuberis of the hypothalamus and its relation to reproduction in the eastern brook trout, *Salvelinus fontinalis*, Dorothy C. Billenstein. Inhibitory control of pars intermedia activity by the brain, William Etkin. Neurosecretion in birds, Donald S. Farner and Andreas Oksche. Actions of neurohypophyseal hormones on the membrane of the toad bladder, Alexander Leaf.

Friday 29 December

Vertebrate Locomotion, Program of the Division of Vertebrate Morphology of the American Society of Zoologists, cosponsored by AAAS Section F–Zoological Sciences. Arranged by D. Dwight Davis, Chicago Natural History Museum, who will preside. Swimming and the origin of paired appendages, J. R. Nursall. Discussion: Hydrodynamic models for the evolution of body form in scombroid fishes, Vladimir Walters. Walking, running, and jumping, Milton Hildebrand. Discussion: T. H. Eaton, Jr. Gliding and flight in vertebrates, D. B. O. Savile. Discussion: Harvey I. Fisher. Locomotion without limbs, Carl Gans. Discussion: Walter Auffenberg. Bipedal locomotion, Richard C. Snyder. Discussion: E. Lloyd Dubrul.

Evolutionary Changes in the Hormonal and Neural Bases of Reproductive Behavior, symposium. Joint program of the Division of Animal Behavior and Sociobiology of the American Society of Zoologists and the Section of Animal Behavior and Sociobiology of the Ecological Society of America, cosponsored by AAAS Sections F–Zoological Sciences and I–Psychology. Arranged by William C. Young, University of Kansas, who will preside. Neural and hormonal factors in sexual behavior in lower vertebrates, Lester R. Aronson. Physiological regulation of reproductive behavior in birds, Daniel S. Lehrman. Neural and hor-

monal factors in sexual behavior in mammals, Robert W. Goy. Sex and the nervous system, Karl H. Pribram.

Concurrent sessions for contributed papers.

VI: **Animal Behavior and Sociobiology, III.** (Sponsorship as in Session I.) William Etkin, Albert Einstein College of Medicine, will preside.

VII: **Developmental Biology, I.** Antone G. Jacobson, University of Texas, will preside.

VIII: **Vertebrate Morphology.** Richard C. Snyder, University of Washington, will preside.

IX: **Comparative Physiology, I.** Arthropod physiology. Nancy S. Milburn, Tufts University, will preside.

Saturday 30 December

Cellular Endocrinology, symposium. Program of the Division of Comparative Endocrinology of the American Society of Zoologists, cosponsored by AAAS Section F–Zoological Sciences. Arranged by Paul A. Wright, University of New Hampshire, who will preside. The role of ionic factors in hormone action on the vertebrate melanophore, Ronald R. Novales. Influence of the parathyroids on frog bone, Roy V. Talmage and Reiko Yoshida. Cellular effects of the thyroid hormone in different organs and species, Henry Lardy and Ya-Pin Lee. Biochemical changes at the cellular level induced by androgens, Charles D. Kochakian. Mechanism of Action of estrogens, Claude Villee.

Concurrent sessions for contributed papers.

X: **Comparative Physiology, II.** James Case, State University of Iowa, will preside.

XI: **Developmental Biology, II.** Stephen Subtelny, Institute for Cancer Research, Philadelphia, will preside.

XII: **Comparative Endocrinology.** Dorothy Price, University of Chicago, will preside.

XIII: **Comparative Physiology, III.** Donald S. Farner, Washington State University, will preside.

XIV: **Developmental Biology, III.** Douglas E. Kelly, University of Colorado, will preside.

In addition, 54 papers will be read by title.

The American Society of Zoologists is a cosponsor of the symposia of the Society of Protozoologists and the Society of Systematic Zoology, and also of the Section on Medical Science's four-session symposium, Physiological and Biochemical Aspects of Human Genetics, 29 and 30 December. Arranged by Alexander G. Bearn, Rockefeller Institute and Oscar Touster, Vanderbilt University. The parts of this are: I: Structure and Specific Action of DNA; II and III: Gene-Protein Relationships; IV: Tissue Culture, Immunological and Evolutionary Aspects.

Library and Book Lounge, jointly sponsored by the American Society of Zoologists and the Society of Systematic Zoology. Open Wednesday, 27 December, through Saturday, 30 December.

Society of Protozoologists

Program chairman: Norman D. Levine.

Wednesday 27 December

Session for Contributed Papers, I. William Trager, Rockefeller Institute, presiding.

Biochemical Phyletic Markers among the Protozoa, round table symposium. Program of the Society of Protozoologists, cosponsored by AAAS Section F–Zoological Sciences. Arranged by Seymour H. Hutner, who will preside. Are there biochemical boundaries to a phylum protozoa? Ellsworth C. Dougherty. Which protozoa (if any) should be called humanoid? Seymour H. Hutner. Biochemical intimations of the phylogenetic position of the ciliates, George G. Holz, Jr. Biochemical taxonomy of trichomonads, John J. Lee.

Executive Committee Dinner and Meeting.

Friday 29 December

Contributed Papers, II. Daniel M. Lilly, St. John's University, Jamaica, New York, presiding.

Annual Luncheon and Business Meeting.

Contributed Papers, III. Robert Samuels, University of Colorado Medical School, presiding.

Saturday 30 December

Contributed Papers, IV. Theodore L. Jahn, University of California, Los Angeles, presiding.

Society of Systematic Zoology

Program chairman: Charles F. Lytle, Tulane University, New Orleans, Louisiana.

27–28 December

The Data of Classification, three-session symposium. Program of the Society of Systematic Zoology, cosponsored by the American Society of Zoologists and AAAS Section F–Zoological Sciences. Arranged by Richard E. Blackwelder, Southern Illinois University, who will preside. Behavioral study in cricket classification, Richard D. Alexander. Distributional data in troglobite classification, Thomas C. Barr, Jr. Nonmorphological data in anuran classification, W. Frank Blair. Reproductive data in classification, H. B. Boudreaux. Precipitin testing and classification, Alan A. Boyden. Host plant relations as data for butterfly classification, John C. Downey. Anatomical data in duck classification, Philip S. Humphrey. Ecological data in classification, Alan J. Kohn. Nonmorphological data in fish classification, Robert R. Miller. Breeding systems in tundra shorebird classification, Frank A. Pitelka. Crystallographic data in echinoderm classification, David M. Raup. Molecular structure of proteins as data for classification, Charles G. Sibley. Osteological data in mammal classification, Howard J. Stains. (The order of speakers will be announced.)

Thursday 28 December

Coffee Hour for all systematists and their guests.

Friday 29 December

Biogeography of the Philippine Islands, two-session symposium. Program of the Society of Systematic Zoology, cosponsored by the American Society of Zoologists and AAAS Section F–Zoological Sciences. Arranged by Walter C. Brown, Natural History Museum, Stanford University and Menlo College, Menlo Park, California, symposium chairman; Alan E. Leviton, California Academy of Sciences; and Charles F. Lytle, Tulane University.

Part I. R. Tucker Abbott, Academy of Natural Sciences of Philadelphia, presiding. Geology and geological history, Grant W. Corby. Phytogeography, Sidney F. Glassman. Recent mollusks, R. Tucker Abbott. Cephalopods, Gilbert L. Voss.

Part II. Walter C. Brown presiding. Fresh-water fishes and Philippine zoogeography, George S. Myers. Reptiles, Walter C. Brown. Birds, Kenneth C. Parkes. Mammals, David H. Johnson. Summary of the symposium, Walter C. Brown.

Saturday 30 December

Annual Breakfast and Business Meeting. Contributed Papers.

Zoological and Botanical Sciences (FG)

Section FG—Societies related to both zoological sciences, F, and botanical sciences, G.

American Society of Naturalists

Wednesday 27 December

President Address. Ernst W. Caspari, University of Rochester, presiding. Man's ecological niche, Marston Bates, professor of zoology, University of Michigan; president, American Society of Naturalists.

Business Meeting. Marston Bates will preside.

Beta Beta Beta Biological Society

Wednesday 27 December

Biennial Business Meeting. H. P. Sturdivant will preside.

Luncheon and Address. H. P. Sturdivant, presiding. Radiation, research, and reason, Martin W. Fleck, University of New Mexico.

Bio (Biomedical Information-Processing Organization)

Wednesday 27 December

Invited Papers. Arranged by Robert S. Ledley, president, National Biomedical Research Foundation, Silver Spring, Md., who will preside. A theory of thinking and the automatic classification of neuropsychiatric behavior disorders, Henry J. Mark. The use of a digital computer for the analysis of genetic linkage in man, Roger W. Sherwin. Patient data processing in the hospital, Charles J. Roach. Computer aids to biochemistry, Robert S. Ledley.

Biometric Society, Western North American Region

Program chairman: Franklin Graybill, director, statistical laboratory, Colorado State University, Fort Collins.

Thursday 28 December

Invited Papers, Session I: Scott Urquhart, Colorado State University, presiding. Quantitative genetic studies on four traits in sugar beets, William Davis and Herbert Bush. Prediction of gamma fractionated-dose LD_{50}'s, W. L. LeStourgeon and J. F. Spalding.

Session II: Joint program of the Biometric Society, Western North American Region, and the American Statistical Association, cosponsored by AAAS Section K–Social and Economic Sciences. James A. Niederjohn, Ideal Cement Company, Denver, presiding. On a generalization of the Poisson distribution, George E. Bardwell. Estimation of multiple contrasts using the multivariate *t*-distribution, Olive Jean Dunn. Canonical correlations and their relationship to factor analysis, F. Reid Creech.

The Biometric Society, WNAR, is a cosponsor of the program of the American Statistical Association.

Ecological Society of America

Chairman, Committee on Meetings: Richard S. Miller, University of Saskatchewan, Saskatoon, Canada.

Wednesday 27 December

Contributed Papers, Session I: General Ecology. Ernest M. Kuhinka, Dickinson College, presiding.

Session II (concurrent): Animal Ecology. Paul W. Winston, University of Colorado, presiding.

Session III: Animal Behavior and Sociobiology, I. Joint session of the Section of Animal Behavior and Sociobiology and the Division of Animal Behavior and Sociobiology of the American Society of Zoologists, cosponsored by AAAS Section I–Psychology.

27–29 December

North American Arctic-Alpine Ecology, symposium in several parts; all sessions of the symposium arranged by the local committee of the Ecological Society of America.

Introduction: The Arctic-Alpine Environment, William S. Cooper, University of Colorado, presiding. Introduction and remarks, Robert W. Pennak. Solar and thermal radiation in the Alpine tundra, David M. Gates. Botanical evidence of glacier activity at Mount Ranier, Washington, Robert W. Sigafoos and E. L. Hendricks. Solar radiation and Alpine plant temperatures, Frank B. Salisbury. The accumulation of snow in Alpine areas, M. Martinelli, Jr. The environment of the Himalayan Tibetan frontier, Lawrence W. Swan. Ecological diagnostics of Alpine lakes, Robert W. Pennak. The Alpine and Subalpine climax region environments of the Front Range, Colorado, John W. Marr.

Part I: Pattern and Process in Arctic-Alpine Vegetation, session I. Eilif Dahl, Agricultural College of Norway, Vollebekk, presiding. Alpine ecosystems of the northern Rocky Mountains, Richard D. Taber, Robert S. Hoffman, Thomas J. Nimlos, and Samuel Bamberg. Landscape relationships of vegetation and soils in the forest-tundra ecotone, Upper Firth River, Alaska and Canada, Royal E. Shanks and James V. Drew. Turf hummocks in northeastern Greenland, Hugh M. Raup. Primary productivity in cirque lakes of the Klamath Mountains, California, Charles R. Goldman. Net primary production and efficiency of tundra plant communities, Lawrence C. Bliss. The effects of visitor impact on Rocky Mountain Alpine tundra, Beatrice E. Willard. Alpine plant communities in relation to cryopedogenic patterns and processes, Philip L. Johnson.

Part I (*cont.*) Pattern and Process in Arctic-Alpine Vegetation, session II (concurrent with part II). Herbert C. Hanson, Berthoud, Colorado, presiding. Investigations of Arctic and Antarctic vegetation by the Institute of Polar Studies, Emanuel D. Rudolph and J. McCormick. Mycotrophy of Alpine shrubs in the Cascade Mountains, James M. Trappe. Successional potential resulting from differential seedling establishment in Alpine tundra stands, William S. Osburn. The influence of frost action on plant distribution in northwestern Alaska, Albert W. Johnson. An ordination of Alpine vegetation, Richard T. Ward. Ecological study of forest-tundra ecotone at Small Tree Lake, Northwest Territories, J. S. Maini. Alpine and Subalpine vegetation patterns in the White Mountains of California, H. A. Mooney, G. St. Andre, and R. D. Wright. Quantitative aspects of the Alpine vegetation of Iztaccihuatl and Popocatepetl, John H. Beaman. Comparative ecology of Arctic and Alpine plants, W. D. Billings.

Part II: Ecology of Arctic-Alpine Invertebrates and Birds (concurrent with part I, session II). Robert W. Pennak, University of Colorado, presiding. Arctic and Subarctic examples of intertidal zonation, D. V. Ellis. Altitudinal succession of Colorado Orthoptera in relation to Hopkins's bioclimatic law, Gordon Alexander. High-altitude ant faunas of Colorado, Robert E. Gregg. Distribution and ecology of Arctic-

Program notes for some sections have appeared in previous issues of *Science*: "Chemistry" and "Mathematics and Related Programs," 27 October, page 1376; "Physics" and "Astronomy," 3 November, page 1438; and "Agriculture," "Geography," and "Geology," 10 November, page 1534.

On page 1616 of this issue appears a coupon which readers can mail in to obtain hotel reservations for the annual meeting.

Alpine butterflies, F. Martin Brown. Some ecological aspects of predation by shrikes in Arctic Alaska, Tom J. Cade. Competition in the genus *Stercorarius* in northern Alaska, William J. Maher. Distribution, overlap, and hybridization of two species of redpolls in Alaska, Paul H. Baldwin.

Part III: Ecology of Arctic-Alpine Mammals (concurrent with part I, session III). Hugo Rodeck, University of Colorado, presiding. Ecology of the terrestrial mammals of the Cape Thompson region, Alaska, William O. Pruitt, Jr. Food habits and some Alpine tundra vegetation interrelationships of the Colorado pika, Mark W. Paddock. The effects of continuous light upon 24-hour activity of Arctic mammals, G. Edgar Folk. Ecological mechanisms in Arctic microtine cycles, Frank A. Pitelka. Caribou year-life history of the barren-ground caribou (*Rangifer arcticus*), William O. Pruitt, Jr.

Part I *(cont.)* **Pattern and Process in Arctic-Alpine Vegetation, session III** (concurrent with part III). W. D. Billings, Duke University, presiding. Considerations of pattern and process in subarctic Alaskan vegetation, W. S. Benninghoff. Vegetation gradients in Arctic Alaska, John Cantlon. The Nunatak theory reconsidered from a biogeographic and geologic point of view, Eilif Dahl. The vegetation of the Nelchina caribou range, Herbert C. Hanson. Alpine floristic components of the southern Rocky Mountains, William A. Weber.

Thursday 28 December

Contributed Papers, Session I: Animal Behavior and Sociobiology, II.

Session II: Plant Ecology, John W. Marr, University of Colorado, presiding.

Friday 29 December

Motion Pictures: Animal Behavior and Sociobiology, III.

Mountain Lake Biological Station

Director: James L. Riopel, University of Virginia, Charlottesville.

Program chairman: Horton H. Hobbs, Jr., University of Virginia.

Friday 29 December

Breakfast. Annual meeting of former students, investigators, and staff.

National Association of Biology Teachers

The program of the NABT will be found in the coordinated programs of the Science Teaching Societies, to appear in a subsequent issue.

Society of General Physiologists

The society is a cosponsor of the symposium on Neurosecretion, of the American Society of Zoologists.

Botanical Sciences (G)

Tuesday 26 December

Session for Contributed Papers. Harriet B. Creighton, Wellesley College, will preside.

Wednesday 27 December

Plant Biology Today: Advances and Challenges, symposium. Joint program of AAAS Section G–Botanical Sciences and the Botanical Society of America. Arranged by Harriet B. Creighton, Wellesley College, who will preside.

Part I: The control of plant growth by environment, Anton Lang. Molecular botany, James F. Bonner. The problem of cell development, William A. Jensen.

Part II: "Biological clocks" in plants, Beatrice M. Sweeney. Photosynthesis, Lawrence Bogorad. Translocation: The movement of dissolved substances within plants, Frank B. Salisbury.

Botanists' Luncheon and Vice Presidential Address. Speaker, James F. Bonner, California Institute of Technology.

Biologists' Smoker. Joint program of AAAS Sections F–Zoological Sciences and G–Botanical Sciences, and all biological societies. Arranged by Tyler A. Woolley, Colorado State University, and Paul W. Winston, University of Colorado. Financed by donations from zoology and biology departments at Colorado State University, University of Colorado, University of Denver, Colorado College, and Colorado State College.

Section G is a cosponsor of the two interdisciplinary symposia, Geochemical Evolution and Existing Levels of Radioactivity in Man and His Environment.

Medical Sciences (N)

29 and 30 December

Physiological and Biochemical Aspects of Human Genetics. Four-session symposium of AAAS Section N–Medical Sciences, cosponsored by AAAS Sections C–Chemistry, H–Anthropology, and Nd–Dentistry, and by the American Society of Zoologists. Arranged by Alexander G. Bearn, Rockefeller Institute, and Oscar Touster, Vanderbilt University.

Part I: Structure and Specific Action of DNA, Gunther S. Stent, University of California, Berkeley, presiding. The biological aspects of the reversible denaturation of DNA, J. Marmur. Studies of the process of replication of a single-stranded DNA, R. L. Sinsheimer. The priming role of DNA and RNA in ribonucleic acid biosynthesis, J. J. Hurwitz. The control of genetic activity, A. E. Mirsky.

Part II: Gene-Protein Relationships, session I, A. G. Bearn, Rockefeller Institute, presiding. The role of gene-specific DNA in the cell-free synthesis of β-galactosidase, G. D. Novelli. The gene and protein structure, David M. Bonner. Gene-protein relationships in human hemoglobin, C. Baglioni. Genetic and biochemical aspects of haptoglobins, O. Smithies.

Part III: Gene-Protein Relationships, session II. B. Childs, Johns Hopkins Hospital, presiding. Genetic control of variations in gamma globulins, A. G. Steinberg. Variants of human glucose-6-phosphate dehydrogenase, H. N. Kirkman. Population genetics of glucose-6-phosphate dehydrogenase deficiency, A. G. Motulsky, Genetics and specificities of antibodies, R. Ceppellini.

Part IV: Tissue Culture and Immunological and Evolutionary Aspects, T. Dobzhansky, Columbia University, presiding.

GRASSLANDS

Editor: Howard B. Sprague **1959**

6" x 9", 424 pp., 37 illus., index, cloth. Price $9.00, AAAS members' cash orders $8.00. AAAS Symposium Volume No. 53.

This volume is intended as a review of knowledge on many aspects of grasslands resources. The 44 authors were selected by their own professional colleagues as being particularly competent to present the respective subjects. Thirty-seven papers are arranged under these chapter headings:

1. Sciences in Support of Grassland Research
2. Forage Production in Temperate Humid Regions
3. Engineering Aspects of Grassland Agriculture
4. Forage Utilization and Related Animal Nutrition Problems
5. Evaluation of the Nutritive Significance of Forages
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Vice Presidential Address. Genetic variations in human structure and function and their influence on medical care, John B. Youmans, director of scientific activities, American Medical Association; vice president for Section N. Presentation of the 17th Theobald Smith Award. Genetic studies with human cells, T. T. Puck. Immunological aspects of human genetics, R. D. Owen. Origin and development of isozymes, C. L. Markert.

Alpha Epsilon Delta

Thursday 28 December

Career Opportunities in the Health Professions. Program of Alpha Epsilon Delta, cosponsored by AAAS Sections C–Chemistry, F–Zoological Sciences, N–Medical Sciences, and Nd–Dentistry, and by Beta Beta Beta Biological Society. Arranged by Norman F. Witt, professor of chemistry, University of Colorado, national president, who will preside. Medical needs for the future, A. N. Taylor. Dental needs for the future, Reidar F. Sognnaes. Panel discussion: Opportunities in medicine, Reginald H. Fitz, moderator. Panel members: Philip B. Price, Bill C. Garoutte, and Philip E. Smith. Panel discussion: Opportunities in dentistry, Hamilton B. G. Robinson, moderator. Panel members: Willard C. Fleming, Harold J. Noyes, and Ben C. McKinney.

Luncheon and Address. The challenges and opportunities in medical education, Robert J. Glaser, vice president for medical affairs, and dean, School of Medicine, University of Colorado Medical Center, Denver.

Conferences with Admissions Officials. Visit to University of Colorado Medical Center.

American Physiological Society

The Society has arranged a joint program for session II of the American Astronautical Society's three-session symposium on Manned Lunar Flight. The Society is the cosponsor of sessions I and III of the symposium [*Science*, **134**, 1438 (3 Nov. 1961)].

American Psychiatric Association

Program chairman: David A. Hamburg, Stanford Medical Center, Palo Alto, California.

Wednesday 27 December

Genetics and Evolution in Relation to Human Behavior. Two sessions: Program of the Committee on Research of the American Psychiatric Association, cosponsored by AAAS Section I–Psychology, and the American Anthropological Association.

Session I, David A. Hamburg, presiding. An outline of human evolution, S. L. Washburn. Baboon behavior, S. L. Washburn and Irven DeVore. Evolution of primate social behavior, Irven DeVore.

Session II. Evolution of culture in Africa, J. Desmond Clark. Selective forces in the evolution of man, Ernst W. Caspari. What is "inheritance of behavior"? Theodosius Dobzhansky.

Dentistry (Nd)

Oral Aspects of Genetics. Two-session symposium of AAAS Section Nd-Dentistry, cosponsored by AAAS Section N–Medical Sciences, the American College of Dentists, American Dental Association, and the International Association for Dental Research, North American Division.

Program chairman: Albert A. Dahlberg, University of Chicago.

Wednesday 27 December

Session I, Albert A. Dahlberg, presiding. Recent advances in dental genetics, Carl J. Witkop, Jr. The respective roles of twin, sibling, family, and population methods in dento-medical studies, Richard H. Osborne. Effects of heredity and environment on the development of the dentition, Jerome D. Niswander. Chromosome nondisjunctions and oral anomalies, Robert Gorlin. The effectiveness of selection in producing laboratory stocks genetically uniform for resistance or susceptibility to dental caries, Harrison R. Hunt and Samuel Rosen.

Session II, Albert A. Dahlberg, presiding. Family studies of the facial complex, Bertram Hanna. Some clinical aspects of genetic research in dentistry, Sidney L. Horowitz. Third molar polymorphism and dental genetics, Stanley M. Garn and Arthur B. Lewis. The regulative changes in tooth germs grown in tissue culture, Shirley Glasstone Hughes. Discussion by symposium participants.

Section Nd is a cosponsor of the program of Alpha Epsilon Delta, of Section N's four-session symposium,

Physiological and Biochemical Aspects of Human Genetics, and of the interdisciplinary symposium, Existing Levels of Radioactivity in Man and His Environment.

Pharmacy (Np)

Wednesday 27 December

Contributed Papers: Hospital Pharmacy. Arranged by George F. Archambault, Don E. Francke, and Joseph A. Oddis.

Session I: George F. Archambault, presiding.

Hospital Pharmacy, Session II: Don E. Francke, presiding.

Vice Presidential Address of Section Np. George F. Archambault, presiding. Pharmacy and hospital pharmacy, Joseph A. Oddis, American Society of Hospital Pharmacists; Division of Hospital Pharmacy, American Pharmaceutical Association: and Vice President of Section Np.

Thursday 28 December

One of the four interdisciplinary symposia at the Denver meeting has been the responsibility of Section Np. The Interdisciplinary Symposium in the Biological-Medical Sciences, **Existing Levels of Radioactivity in Man and His Environment: Measurement and Significance**, is a joint program of AAAS Sections Np–Pharmacy, F–Zoological Sciences, G–Botanical Sciences, H–Anthropology, I–Psychology, N–Medical Sciences, Nd–Dentistry, O–Agriculture, and Q–Education. Arranged by John E. Christian, Purdue University, who will preside. Introductory remarks and radioisotope demonstrations, John E. Christian. Radioactivity levels in man and his environment—contribution and potential hazards of reactor and isotope-powered vehicles, Wright H. Langham. Existing levels of cosmic-ray produced radioactivity—present and potential applications to archeology, meteorology, geochronology, and oceanography, James R. Arnold. Measurements of the existing radioactivity of people and foods. Applications of nondestructive measurements of body composition (potassium, lean, fat, water), medical diagnosis, age studies, and fall-out studies. Ernest C. Anderson. The relationship of existing radiation levels to carcinogenesis, P. R. J. Burch. Question and discussion session.

The seven remaining sessions of the program of AAAS Section Np–Phar-

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macy are cosponsored by the American Pharmaceutical Association, Scientific Section; American Association of Colleges of Pharmacy; American Society of Hospital Pharmacists; American College of Apothecaries; and the National Association of Boards of Pharmacy.

Friday 29 December

Contributed Papers. Arranged by John E. Christian. John Autian, University of Texas, and Wayne Kessler, Purdue University, presiding.

Meetings

Electron Microscopy

The 19th annual meeting of the Electron Microscope Society of America was held in Pittsburgh, Pennsylvania, from 23 to 26 August 1961. This meeting brought together more than 706 active workers in electron microscopy from 24 states, Canada, Australia, Great Britain, Belgium, Germany, and Japan. It was the largest meeting in the history of the society. There were ten general sessions of contributed papers (five in the biological fields, five in nonbiological areas), a special session on techniques, and three symposia. There were 19 scientific exhibits and some 180 contributed papers on the techniques and applications of the electron microscope to studies in biology, chemistry, medicine, cancer, metallurgy, electron diffraction, and related fields.

In the symposium on the contribution of electron microscopy to polymer morphology, organized by R. G. Scott (Du Pont Experimental Station), seven experts in this field discussed, respectively, x-ray diffraction as applied to polymers, spherulites, electron diffraction as applied to single crystals, the morphology of polymers, fiber microscopy, and electron diffraction as applied to synthetic fibers. This symposium summarized the new phases of technology and applications of electron microscopy in the field of polymer science.

Rubin Borasky (University of Illinois) arranged and directed the symposium on ultrastructure of protein fibers. The papers on physical, chemical, and mechanical properties of protein fibers in muscle and keratin summarized the recent contributions to the science of fiber structure.

The symposium on the fine structure of viruses, arranged by A. F. Howatson (University of Toronto), was especially noteworthy in that the presentation of papers on recent advances in fine structure, animal virus structure, electron microscopy of nucleic acids and proteins, structures of bacteriophages, and studies on the fine structure of foot-and-mouth-disease virus brought together, in a very logical sequence, information on the recent improvements in the techniques of replication, shadow-casting, thin sectioning, and "negative-contrast" staining and their application and interrelationships in obtaining new information on the structure of viruses.

President D. Maxwell Teague and president-elect Keith R. Porter and the organizing committee announced plans and arrangements for the 5th International Congress for Electron Microscopy, to be held in Philadelphia from 29 August through 5 September 1962.

The Electron Microscope Society of America will be host to the International Federation of Electron Microscope Societies at this congress, which will emphasize the new and unique

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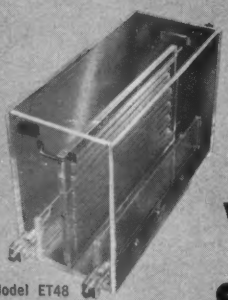

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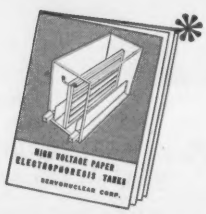

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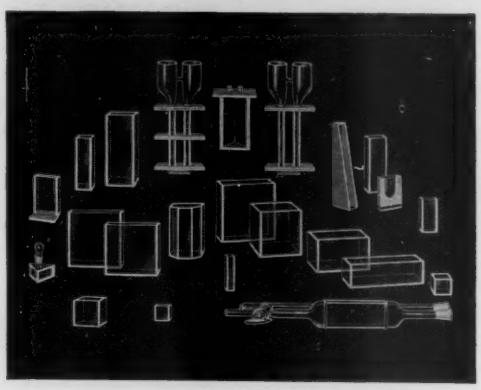

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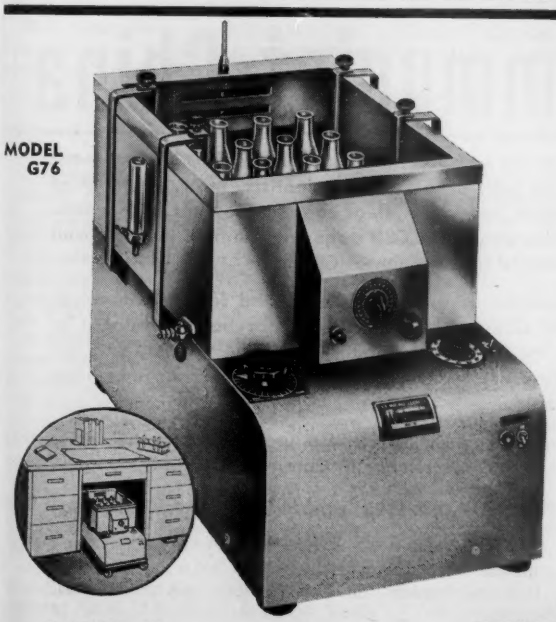

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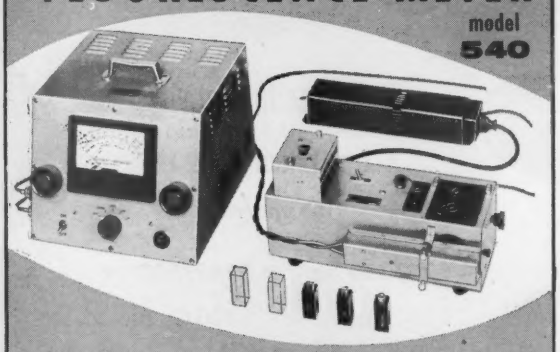

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contributions of electron microscopy in many areas of science. The organizing committee co-chairmen are T. F. Anderson and J. H. Reisner; S. S. Breese, Jr., is program chairman. Limited funds will be available to assist enrolled students of electron microscopy in the United States in attending the congress. Requests for information should be addressed to Fifth International Congress for Electron Microscopy, 7701 Burholme Ave., Philadelphia 11, Pa.

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Forthcoming Events

November

29–1. Communication Wires and Cables, symp., Asbury Park, N.J. (H. Kingsley, U.S. Army Research and Development Laboratory, Fort Monmouth, N.J.)

29–1. Western Surgical Assoc., San Francisco, Calif. (W. W. Carroll, 700 N. Michigan Ave., Chicago 11, Ill.)

30. American Geographical Soc., New York, N.Y. (C. W. Bastable, Columbia Univ., New York 27)

30–1. Conference on Graduate Medical Education, Philadelphia, Pa. (P. Nemir, Jr., Dean, Graduate School of Medicine, Univ. of Pennsylvania, Philadelphia)

30–1. Vehicular Communications, Minneapolis, Minn. (J. Kahnke, Minneapolis-Honeywell, Aero Div., 1541 Edgewater Ave., St. Paul 13, Minn.)

December

1. Symposium on Insulin, New York Diabetes Assoc., New York, N.Y. (New York Diabetes Assoc., 104 E. 40 St., New York 16)

1–2. Linguistic Circle of New York, 7th annual conf., New York, N.Y. (L. Urdang, Random House, Inc., 501 Madison Ave., New York 22)

2. International College of Surgeons, intern. executive council, Chicago, Ill. (H. E. Turner, 1516 Lake Shore Dr., Chicago)

2. New York State Registry of Medical Technologists, annual seminar, New York, N.Y. (S. H. Keeling, 1719 Midland Ave., Syracuse, N.Y.)

2–7. American Acad. of Dermatology and Syphilology, annual, Chicago, Ill. (R. R. Kierland, Mayo Clinic, Rochester, Minn.)

3–6. American Inst. of Chemical Engineers, New York, N.Y. (F. J. Van Antwerpen, AICE, 345 E. 47 St., New York 17)

4–6. Institute of the Aerospace Sciences, Aerospace Support and Operations, natl., Orlando, Fla. (R. J. Kotowski, 318 Virginia Dr., Melbourne, Fla.)

4–8. International Colloquium on Ionic Bombardment, Bellevue, France. (Natl. Scientific Research Center, 15 Quai Anatole France, Paris 7°, France)

4–9. Mathematics Instruction at Secondary and University Levels, Inter-American conf., Bogota, Colombia. (M. Alonso, Div. of Science Development, Pan American Union, Washington 6)

4–9. World Federation of Neurology, Problem Commission of Tropical Neurology, Buenos Aires, Argentina. (P. Bailey, Natl. Inst. of Neurological Diseases and Blindness, Bethedsa, Md.)

4–16. Inter-American Conf. on Education and Economic and Social Development, Santiago, Chile. (U.S. National Commission for UNESCO, Dept. of State, Washington 25)

4–16. Latin American Phytotechnical Meeting, 5th, Buenos Aires, Argentina. (U. C. Garcia, Organizing Committee, Rivadavia 1439, Buenos Aires)

5–7. Building Research Inst., Washington, D.C. (Scientific Liaison Office, Natl. Research Council, Sussex Dr., Ottawa, Canada)

5–8. United States and Japan Atomic Industrial Forums on Nuclear Power, 2nd conf., Tokyo, Japan. (C. Robbins, Executive Manager, Atomic Industrial Forum, 3 E. 54 St., New York 22)

6–7. UNESCO Intern. Non-Governmental Organizations on Extension of Intern. Collaboration in Education, Science and Culture to Africa, Paris France. (Place de Fontenoy, Paris 7°)

6–8. Conference on Document Copying by Photography, London, England. (A. J. O. Axford, Ozalid Co., Longston Rd., Loughton, Essex, England)

6–8. Electrical Furnace Steel Conf., 19th, American Inst. of Mining, Metallurgical and Petroleum Engineers, Pittsburgh, Pa. (Scientific Liaison Office, Natl. Research Council, Sussex Dr., Ottawa, Canada)

6–8. Latin-American Congr. of Pathological Anatomy, 3rd, Medellín, Colombia. (A. C. Henao, Laboratorio de Anatomía Patológica, Rua Botucatu 720, São Paulo, Brazil)

6–8. National Institutes of Health Symp. on Neuroendocrinology, Miami, Fla. (A V. Nalbandov, 102 Animal Genetics, Univ. of Illinois, Urbana)

6–12. American Acad. of Optometry, Chicago, Ill. (C. C. Koch, 1506–08 Foshay Tower, Minneapolis 2, Minn.)

6–16. Food and Agriculture Organization of the U.N. World Health Organization, Nutrition Conf. for the Far East, 5th, Hyderabad, India. (Intern. Agency Liaison Branch, Office of Director General, FAO, Viale delle Terme di Caracalla, Rome, Italy)

6–16. Food and Agriculture Organization of the U.N., Far East Meeting on Animal Production and Health, 3rd, Bangkok, Thailand. (Intern. Agency Liaison Branch, Office of Director General, FAO, Viale delle Terme di Caracalla, Rome, Italy)

7–8. Symposium on Sintered High-Temperature Oxidation-Resistant Materials, London, England. (S. C. Guilan, Powder Metallurgy Joint Group, Inst. of Metals, 17 Belgrave Sq., London)

7–9. American Chemical Soc. Southwest-Southeast regional meeting, New Orleans, La. (P. D. Accardo, California Chemical Co., Oronite Div., Belle Chasse, La.)

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7–9. New York Acad. of Sciences Conf. on the Cervix, New York, N.Y. (W. R. Lang, Jefferson Medical College, Philadelphia, Pa.)

7–9. Texas Acad. of Science, Galveston. (D. E. Edmondson, Mathematics Dept., 115 Bendect Hall, Univ. of Texas, Austin 12)

8. Food and Agriculture Organization of the U.N., Advisory Group on Training in Home Economics and Social Work, Rome, Italy. (Intern. Agency Liaison Branch, Office of Director General, FAO, Viale delle Terme di Caracalla, Rome)

8–9. American Rheumatism Assoc., interim session, Washington, D.C. (F. E. Demartini, 622 W. 168 St., New York 32)

8–9. Association for Research in Nervous and Mental Diseases, annual, New York, N.Y. (Scientific Liaison Office, Natl. Research Council, Sussex Dr., Ottawa, Canada)

8–9. Symposium on Plasma Membrane, New York, N.Y. (A. P. Fishman, New York Heart Assoc., 10 Columbus Circle, New York 19)

8–10. American Psychoanalytic Assoc., New York, N.Y. (D. Beres, 151 Central Park W., New York 23)

9–10. Academy of Psychoanalysis, New York, N.Y. (J. H. Merin, 125 E. 65 St., New York 21)

10–13. American Phytopathological Soc., Biloxi, Miss. (G. A. Zentmyer, Dept. of Plant Pathology, Univ. of California, Riverside)

10–14. Psychosomatic Medicine Symp., 6th, Philadelphia, Pa. (Miss M. R. Carmosin, Hahnemann Medical College and Hospital, 235 N. 15 St., Philadelphia 2, Pa.)

10–17. Latin American Congr. on Microbiology, 2nd, San José, Costa Rica. (J. L. De Abate, Secretary General, Apartado 1404, San José)

11. Society of Photographic Scientists and Engineers, Washington, D.C. (C. M. Bailey, Rte. 4, Box 404, Fairfax, Va.)

11–15. Agricultural and Public Health Aspects of Radioactive Contamination in Normal and Emergency Situations, technical seminar, The Hague, Netherlands. (Food and Agriculture Organization of the U.N., Intern. Agency Liaison Branch, Office of the Director General, Viale delle Terme di Caracalla, Rome, Italy)

11–15. Symposium on Organization of Agricultural Research, Muguga, Kenya. (Commission for Technical Cooperation in Africa South of the Sahara, Pvt. Mail Bag 2359, Lagos, Nigeria)

11–16. Ionospheric Soundings in the Intern. Geophysical Year/Intern. Geophysical Cooperation–1959 Symp., Nice, France. (A. H. Shapley, URSI World-Wide Soundings Commission, Central Radio Propagation Laboratory, Natl. Bureau of Standards, Boulder, Colo.)

12–14. Association for Computing Machinery, eastern joint computer conf., Washington, D.C. (B. Oldfield, I.B.M. Corp., 326 E. Montgomery, Rockville, Md.)

12–15. American Soc. of Agricultural Engineers, Chicago, Ill. (J. L. Butt, ASAE, 420 Main St., St. Joseph, Mich.)

13. American Acad. of Arts and Sciences, Brookline, Mass. (J. L. Oncley, 280 Newton St., Brookline 46)

15–16. Oklahoma Acad. of Science, Stillwater. (D. Buck, Northern Oklahoma Junior College, Tonkawa)

17–18. International Congr. of Comparative Pathology, 9th, Paris, France. (L. Grollet, Comité International Permanent des Congrès de Pathologie Compareé, 63 Avenue de Villiers, Paris 17°)

19–23. Inter-American Congr. of Psychology, 7th, Monterrey, Mexico. (G. M. Gilbert, Psychology Dept., Long Island Univ., Brooklyn 1, N.Y.)

22–29. Plant Tissue and Organ Culture, intern. symp., New Delhi, India. (P. Maheshwari, Univ. of Delhi, Delhi)

26–28. History of Science Soc., annual, Washington, D.C. (J. C. Greene, 1121 Iowa Ave., Ames, Iowa)

26–31. American Assoc. for the Advancement of Science, annual, Denver, Colo. (R. L. Taylor, AAAS, 1515 Massachusetts Ave., NW, Washington 5)

The following 35 meetings are being held in conjunction with the AAAS annual meeting.

AAAS Southwestern and Rocky Mountain Div., Committee on Desert and Arid Zones Research (M. G. Anderson, University Biological Station, Pulston, Mich.). 26–31 Dec.

Alpha Epsilon Delta (M. L. Moore, 7 Brookside Circle, Bronxville, N.Y.). 28 Dec.

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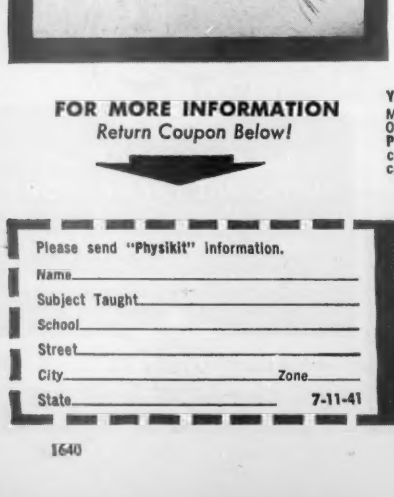

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American Assoc. of Clinical Chemists (R. L. Dryer, State Univ. of Iowa, Dept. of Biochemistry, Iowa City). 26–27 Dec.

American Astronautical Soc. (J. Campbell III, R.C.A., Front and Cooper Sts., Bldg. 10-7, Camden, N.J.). 26–30 Dec.

American Astronomical Soc. (H. J. Smith, Yale Observatory, 135 Prospect St., New Haven, Conn.). 27–30 Dec.

American Economic Assoc. (J. W. Bell, Northwestern Univ., Evanston, Ill.). 26 Dec.

American Educational Research Assoc. (G. T. Buswell, 1201 16 St., NW, Washington 6). 30 Dec.

American Meteorological Soc. (J. M. Austin, Dept. of Meteorology, Massachusetts Inst. of Technology, Cambridge 39). 26–31 Dec.

American Nature Study Soc. (B. Schultz, Dept. of Biology, Western Michigan Univ., Kalamazoo). 26–30 Dec.

American Physiological Soc. (R. G. Daggs, APS, 9650 Wisconsin Ave., Washington 14). 28 Dec.

American Political Science Assoc., (E. M. Kirkpatrick, 1726 Massachusetts Ave., NW, Washington 6). 27 Dec.

American Psychiatric Assoc. (M. Ross, APA, 1700 18 St., NW, Washington 9). 27 Dec.

American Soc. of Criminology (J. Chwast, New York Inst. of Criminology, 115–117 W. 42 St., New York 36). 29–30 Dec.

American Soc. of Naturalists (E. L. Green, Roscoe B. Jackson Memorial Laboratory, Bar Harbor, Maine). 27 Dec.

American Soc. of Zoologists (C. B. Metz, Dept. of Oceanography, Florida State Univ., Tallahassee). 28–30 Dec.

American Sociological Assoc. (T. Parsons, Emerson Hall, Cambridge 38, Mass.). 28–29 Dec.

American Statistical Assoc. (D. C. Riley, ASA, 1757 K St., NW, Washington 6). 29–30 Dec.

Association of American Geographers, Great Plains–Rocky Mountain Div., (M. F. Burrill, AAG, 1785 Massachusetts Ave., NW, Washington, D.C.). 29–30 Dec.

Beta Beta Beta Biological Soc. (F. G. Brooks, Box 515, Ansonia Station, New York 23). 27 Dec.

Colorado-Wyoming Acad. of Science (R. G. Beidleman, Zoology Dept., Colorado College, Colorado Springs).

Ecological Soc. of America (J. E. Cantlon, Dept. of Botany and Applied Pathology, Michigan State Univ., E. Lansing). 26–30 Dec.

Institute of Management Sciences (W. Smith, Inst. of Science and Technology, Univ. of Michigan, Ann Arbor). 29 Dec.

Mathematical Assoc. of America, Committee on Undergraduate Program in Mathematics (H. L. Alder, MAA, Univ. of California, Davis). 30 Dec.

National Assoc. of Biology Teachers (H. C. Kranzer, Temple Univ., Philadelphia 22, Pa.). 26–30 Dec.

National Assoc. for Research in Science Teaching (H. A. Branson, Dept. of Physics, Howard Univ., Washington 1). 26–30 Dec.

National Assoc. of Science Writers (D. J. Dunham, Cleveland Press, Cleveland 14, Ohio).

National Science Teachers Assoc. (M. T. Ballou, Ball State Teachers College, Muncie, Ind.). 26–30 Dec.

National Speleological Soc. (D. N. Cournoyer, 2318 N. Kenmore St., Arlington 1, Va.). 29 Dec.

Scientific Research Soc. of America (D. B. Prentice, 51 Prospect St., New Haven, Conn.). 29 Dec.

Sigma Delta Epsilon (B. L. McLaughlin, 702 Butternut St., NW, Washington 12). 26–30 Dec.

Society of Protozoologists (N. D. Levine, College of Veterinary Medicine, Univ. of Illinois, Urbana). 27–30 Dec.

Society of the Sigma Xi (T. T. Holme, 51 Prospect St., Yale Univ., New Haven, Conn.). 29 Dec.

Society of Systematic Zoology (R. T. Abbott, Acad. of Natural Sciences, Philadelphia 3, Pa.). 27–30 Dec.

Tau Beta Pi Assoc. (R. H. Nagel, Univ. of Tennessee, Knoxville). 29 Dec.

United Chapters of Phi Beta Kappa (C. Billman, 1811 Q St., NW, Washington 9). 29 Dec.

27–29. American Folklore Soc., Cincinnati, Ohio. (T. P. Coffin, 110 Bennett Hall, Univ. of Pennsylvania, Philadelphia 4)

27–29. American Geophysical Union, 1st Western natl., Los Angeles, Calif. (A. N. Sayre, U.S. Geological Survey, Washington 25)

(See issue of 20 October for comprehensive list)

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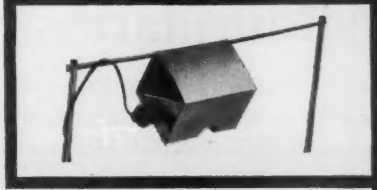

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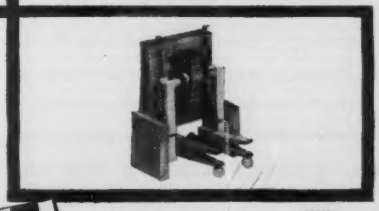

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OPTICAL COMMUNICATIONS Gordon Jacobs, an Electronics Laboratory communications engineer, recently reported that a ruby laser burst system using 350 watts of primary power can provide a range of 10,000 nautical miles at 400 bits per second. In an experimental system development at the Laboratory a KDP crystal was used to modulate the light source frequencies up to 200 mc. The optical receiver utilized a multiplier phototube. Mr. Jacobs stated that future improvements in light sources offer an enormous potential for optical communications. A considerable technical effort is required in many areas: e.g. atmospheric propagation, wide-band modulation and wide-band detection.

ADAPTIVE NEURON COMPONENT Thomas Bray, of the Electronics Devices & Networks group, presented a paper a short time ago describing "An Electro-Optical Shift Register" which employs an adaptive neuron component. This artificial neuron utilizes optoelectronic elements as analog multipliers. (Extremely low volume is an advantage of this Shift Register: a 20-input component consisting of more than 40 analog multipliers and 20 analog memory elements occupies about 2.5 cubic inches.) This work of Mr. Bray's is part of the Laboratory's endeavor in the field of new logic and memory techniques development.

A SCHEME TO CREATE A "RADIOWAVE ATMOSPHERE" NEAR THE MOON ...has been proposed by Dr. Frank Dickey, radar consultant with the Laboratory. He suggested "a powerful earth-based transmitter be employed to beam microwave energy at the moon. The interaction of incident and reflected energy near the lunar surface would create a stationary radiowave pattern...which would be sensed by an incoming spacecraft. This new technique can provide a simple, lightweight device capable of performing all sensory functions needed to achieve soft lunar landings." (First reported at IRE Convention in March 1961, theoretical work is continuing on this concept.)

THE CARDIAC PACEMAKER Electronics Laboratory engineers, headed by Jerome J. Suran, Manager of the Electronic Applications Laboratory, developed this device to control the beat of the human heart. It is the first surgically implantable unit whose rate can be adjusted by the patient to accommodate strenuous activities, such as stair-climbing. Its successful use was described in the May '61 issue of LIFE MAGAZINE. A continuing program of cooperation with medical researchers is now part of the Laboratory effort. It includes work on mechanisms that will stimulate other muscles which have suffered deterioration (from paralytic disease or injury) and the development of new diagnostic techniques.

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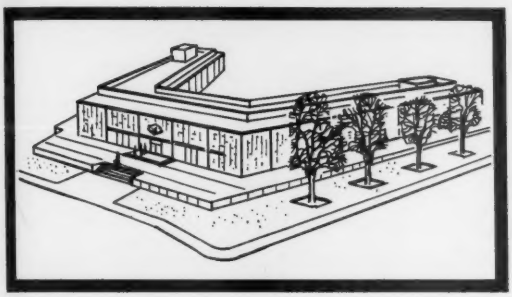

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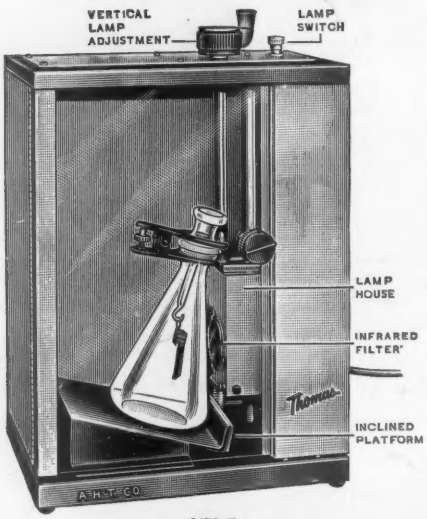
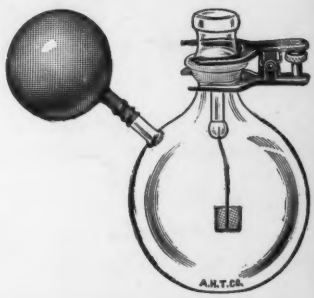
- *Flask shielded completely during ignition and combustion*
- *Takes flasks 500 to 2000 ml capacity*



6472-B.
Showing 6471-P10 Ogg Flask in position *(Flask not included)*.

6471-P10.



6474-G10.

OXYGEN FLASK SAFETY IGNITER,* Thomas-Ogg. For combustion of organic materials in a closed oxygen flask completely shielded within a safety cabinet. Utilizes a focused infrared beam from a built-in 150-watt lamp and special black paper sample wrappers for rapid ignition in an oxygen-charged clamp-closed flask. Vertical alignment of the sample in the beam, and push-button firing are done from outside the cabinet after door is fastened.

Cabinet is of metal, 12¼ × 8 × 16 inches high overall, with transparent acrylic plastic door with full-length hinge, baffled vents and spring-loaded latch. Lamp is mounted in housing with screw crank elevating device; fixed focusing reflector is sealed within lamp envelope. Inclined platform tilts flask to bring sample close to lamp. Flask can be adjusted from front to rear from outside cabinet.

Designed for use with Thomas-Ogg combustion Flask, but accommodates any flask up to 2000 ml, such as Thomas-Lisk, in which stopper can be clamped securely.

6472-B. Safety Igniter, Thomas-Ogg, as described, with flask platform, infrared filter, 100 black paper sample wrappers, extra lamp bulb, 3-wire cord, 3-prong plug with adapter and directions for use, but without combustion flask. For 115 volts **165.00**

OXYGEN COMBUSTION FLASKS,* Thomas-Ogg, of borosilicate glass, conical, designed especially for use in Ogg Safety Igniter but can also be used separately. Mouth is formed by socket of spherical joint 35/25, and stopper fabricated from matching ball member. Stopper has extension with hook for suspending the detachable sample carrier. Carrier is of perforated platinum sheet 1¾ inches long × ⅜-inch wide. Stopper is held securely during combustion by Thomas Pinch Clamp and can be tilted to permit easy release of vacuum following combustion.

6471-P10. Oxygen Flask, Thomas-Ogg, as described, 500 ml capacity, complete with stopper, clamp and platinum sample carrier, but without sample wrappers **41.70**
Each, in lots of 12 or more **39.65**
6471-P15. Ditto, but 1000 ml capacity **42.50**
Each, in lots of 12 or more **40.40**

OXYGEN COMBUSTION FLASKS, Thomas-Lisk, of borosilicate glass, with side arm to take rubber balloon for safe expansion of gases. Designed for determination of pesticide residues in 50 to 100 mg plant extracts but suitable for general samples requiring 1000 or 2000 ml of oxygen. See Donald J. Lisk, *Agricultural and Food Chemistry, Vol. 8, No. 2 (1960), p. 119.* With mouth formed by socket of spherical joint 35/25 and stopper fabricated from matching ball member. Stopper has extension into which is sealed the stem of a platinum sample carrier, U-shape, 18 × 20 mm. Can be used with Infrared Igniter or separately.

6474-G10. Oxygen Flask, Thomas-Lisk, as described, round bottom, 1000 ml capacity, complete with stopper, clamp and 144 rubber balloons, but without sample wrappers .. **54.20**
6474-G20. Ditto, round bottom, 2000 ml capacity **55.45**
6474-G30. Ditto, conical, 1000 ml capacity **54.45**

6471-Q25. Sample Wrappers, Black Paper. Quickly absorb heat for prompt infrared ignition. Die-cut from unsized paper, with integral fuse. Sample area 32 × 30 mm, with fuse 8 × 38 mm. Per box of 100 ..... .50
10% discount in lots of 12 — 15% discount in lots of 72

*Patent applied for. Based on developments by Clyde L. Ogg and associates, Eastern Utilization Research and Development Division, A.R.S., U.S.D.A., Philadelphia, Pa. Described at the International Symposium on Microchemical Techniques, August, 1961.

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